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CONTENTS

THE APPLICABILITY AND EFFICIENCY OF THE ULTRASOUND EXAMINATION IN THE EVALUATION OF BONE HEALING PROCESS IN CHILDREN

Maria Daniela Trăilescu[1,2], Adrian Ionel Pavel[1,2], Camelia Doina Popescu[3], Alexandru Mircea Pop[1]

Abstract

The introduction of minimally invasive osteosynthesis techniques in pediatric trauma requires the implementation of non-invasive methods of monitoring in the postoperative period until cure, new methods with no adverse effects on the young organism. The use of ultrasound in musculoskeletal pathology and traumatology has expanded rapidly over the last decade. While diagnostic ultrasound has been widely adopted in the field of soft-tissue pathology, ultrasound is not in routine use for fracture diagnosis or in the evaluation of bone healing process. Ultrasound examination of bone and periosteum is permissible using high frequency linear transducers. In addition, using power Doppler in the ultrasound examination of the musculoskeletal system can bring valuable local information about blood flow, which is important in assessing the favorable evolution of a fracture to heal.

Keywords: fractures, children, titanium elastic nails osteosynthesis, ultrasound, non-invasive assessment

Introduction

Although ultrasound is a fast, easy and long-used diagnostic imaging method in medical practice, for a long time it did not find its utility in orthopedics and traumatology, being considered useless due to the increased bone impedance, impenetrable by ultrasound. Precisely through this increased bone impedance, ultrasound is fully reflected at the bone surface, determining the hyperechoic appearance of the bone structure [1-4]. Ultrasound examination of the bone and periosteum is permissive by using linear transducers with a high frequency of 7.5-13 MHz Although the positive diagnosis of a fracture is established by radiography, ultrasound can reveal the fracture site, especially in children, where the periosteum takes off more easily, and the secondary hematoma is better represented as an interruption of the hyperechoic bone interface in case of fractures without displacement, or as an unevenness, more or less obvious, in the case of displacement fractures, consistent with the degree of displacement. In addition, the use of the power Doppler Effect in the ultrasound examination of the musculoskeletal system can bring valuable local information related to blood flow, important in assessing the favorable evolution and establishing the prognosis of fracture healing [5-7].

Purpose

The primary objectives of our research are to assert the use and validity of musculoskeletal ultrasound as a non-invasive imaging method for identifying and evaluating bone callus in the dynamics of the post interventional bone healing process, as well as demonstrating particular aspects of the evolution to cure the fracture site stabilized with titanium elastic nails. Ultrasounds performed at the level of a fracture site stabilized by minimally invasive osteosynthesis were performed easily, away from the place of insertion of osteosynthesis materials, and implicitly away from the surgical wound. The ultrasound examination maneuver, which aimed to examine the fracture site in the transverse and longitudinal plane, did not cause additional discomfort to the patients. By centromedullary placing of the elastic titanium nails, the fracture site is viewable during ultrasound, there is no interposition between the site fracture and the linear transducer.

We chose the following intervals of ultrasound examination of the fracture site according to the three important stages of indirect bone healing, specific to the chosen orthopedic surgery technique, during which ultrasound examination of local vascularization is a predictive factor for favorable or unfavorable prognosis of fracture healing. These are represented by the cell proliferation stage, the fibrous callus stage and the consolidation stage. We excluded the hematoma phase from the first 7 days and the remodeling phase that occurs after 30 days because the vascularization adjacent to the fracture site is poorly represented.

The musculoskeletal ultrasound examination and the Doppler ultrasound examination of the fracture site was performed by the same operator, with the same ultrasound device, thus removing the subjective factor, dependent on the examining physician.

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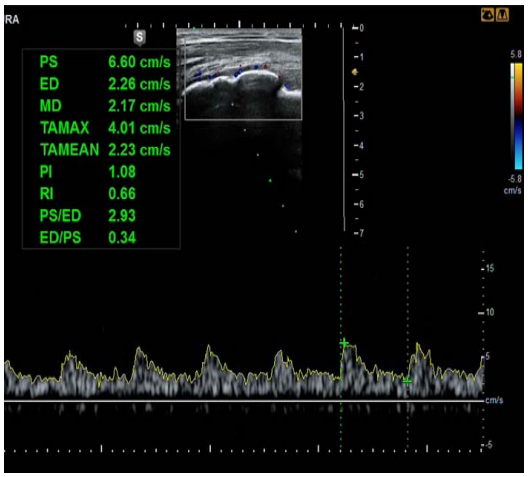
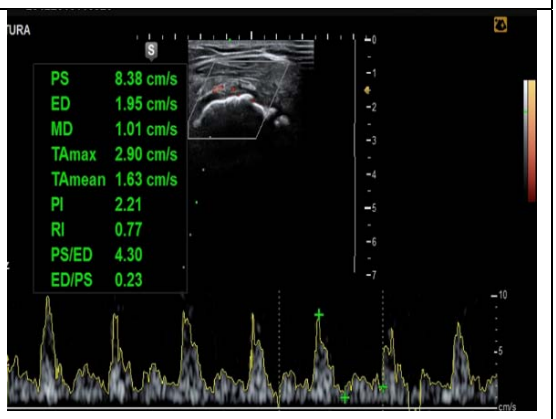
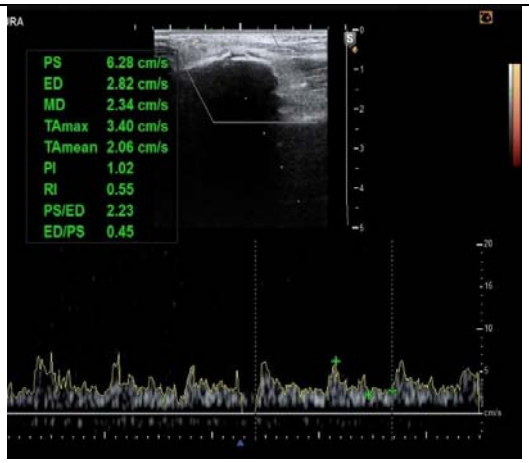
Table I. Results of the ultrasound and power Doppler study of the fracture site

Ultrasound appearance		Ultrasound examples
At 10 days postoperative	1. Periost detached at the level of the fracture site with minimal interruption of continuity 2. Underlying periosteum on the detached area, hypoechoic image, more or less inhomogeneous - post-fracture hematoma 3. Visualization of the fracture site 4. Doppler examination - neoformation vessels adjacent to the fracture site with RI 0.50-0.70	
At 20 days postoperative	1. The area above the periosteum is more homogeneous, with a tendency to hyperechoicity - exogenous fibrous callus 2. Doppler examination - higher number of neoformation blood vessels compared to the previous examination, with more intense Doppler activity with RI 0.65-0.85	
At 30 days postoperative	1. Periosteal callus, exogenous, hyperechoic - partial visualization of the fracture focus 2. Doppler examination - neoformation vessels decrease in numerical representation and caliber - weak Doppler signals at the fracture site with RI 0.30-0.55. 3. Artifacts given by the initiation of the bone callus process	

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The results of the fracture site obtained by ultrasound examination of the fracture site performed at 30 days was compared with the radiological examination of the fracture site performed at the same postoperative time interval, as a radiography is the universally recommended method of monitoring fracture healing one month after the surgery.

Material and methods

This prospective study was held over a three-year period from 2015 until 2018 covering 167 children aged 5 to 18 years, admitted to the Department of Pediatric Surgery and Orthopedics, Emergency County Hospital, Arad, Romania with therapeutic indication for osteosynthesis for displaced diaphysis fractures of the humerus, forearm, femur and tibia.

In all cases, we practiced minimally invasive osteosynthesis with titanium elastic nails (TEN). The ultrasound examination was performed with a Samsung UGEO H60 ultrasound device, equipped with musculoskeletal software, power Doppler and a linear LA3-14AD transducer with a frequency of 7-13 MHz

Patients were monitored postoperative by ultrasound at the established time intervals, respectively at 10 days, 20 days and 30 days. During ultrasound examination measurements of the callus were performed. Using the power Doppler callus vascularity was visualized and vascular resistance index (RI) was measured.

The results obtained by ultrasound at 30 days postoperative were compared with radiograph measurements and with the assessment of the callus quality.

Results

At 10 days after osteosynthesis, musculoskeletal ultrasound clearly reveals the fracture site, the distance between the fracture fragments, the more or less hypoechoic local hematoma, and the degree of periosteal detachment. Doppler examination identifies the appearance of neoformation vessels adjacent to the interrupted periosteum. The visualization of neoformation vessels, with a fine linear appearance on longitudinal sections, or with a punctiform appearance on cross sections, represents a favorable prognostic factor for fracture healing -Table I. Doppler determination of vascular resistance index values in neoformation vessels involves patience and extra time, as the patient's movement can yield numerous artifacts. The values of the vascular resistance index measured at this time were between 0.50 -0.70, with differences depending on the ultrasound explored segment.

At 20 days after osteosynthesis, musculoskeletal ultrasound clearly detects the fracture site, the distance between the fracture fragments, more or less hyperechoic, more organized exogenous fibrous callus, thickened periosteum and hyperechoic. Doppler examination identifies neoformation vessels, better represented numerically and with a larger caliber than in the previous examination, adjacent to the better visible periosteum. The values of the vascular resistance index measured at this time were between 0.65 -0.80.

At 30 days after osteosynthesis, musculoskeletal ultrasound partially detects the fracture site, but between the fracture ends and their overlying is the presence of bone callus, as a hyperechoic bridge, irregular, measurable in length and thickness by clear delimitation of adjacent soft tissues. Doppler examination identifies poorly represented and smaller caliber neoformation vessels than in the previous examination. The values of the vascular resistance index measured at this time were between 0.30 -0.55.

The comparative ultrasound and radiological studies of the fracture site performed at 30 days identifies the presence of the periosteal callus. On an ultrasound, periosteal callus, exogenous, hyperechoic allows partial visualization of the fracture site and osteosynthesis material.

Radiologically, the appearance of unstructured, partially mineralized osseous callus is identified, with the vague visualization of the fracture line, which still remains clearly detectable. The appearance of the callus has a lower color intensity than normal bone tissue.

The comparative studies, at 30 days postoperative, of the results of the two imaging examinations confirmed the ultrasound detection of the callus in 95% of the examined cases, while the radiological examination showed the callus in 74% of the cases - Fig.1.

The analysis of the cases in which the callus was identified by the two methods, respectively 74% of cases, clearly showed that musculoskeletal ultrasound is an imaging method clearly superior to radiography, by earlier identification and much more accurate callus measurement, the dimensions of the callus measured ultrasound showing values 1.5-2 mm larger than those determined radiologically in all cases - Fig. 2.

Discussions

Although there are treatises or atlases of musculoskeletal ultrasound in which there are descriptions of recent fractures, in current practice the positive diagnosis of fracture is commonly established by radiological examinations, the few existing studies in the literature bringing discordant data about false negative or positive ultrasound diagnosis results.

The use of ultrasonography in bone evaluation raised and still raises a lot of controversies.

Ultrasound allows to show only the outer surface of the bone, with no access to the trabecular bone. Moreover, not every area of the bone is available to ultrasound [8].

Despite these major disadvantages the publications show a high correlation of ultrasonography with radiographs in the diagnosis of sternum and long bone fractures, as well as in the evaluation of fractures in children [9,10].

Based on the research, it was found that vascular resistance and vessel density in the callus are greatest during the initial healing phase and gradually decrease from the 3–4 week after the fracture.

Analysis of the results showed a high value of ultrasonographic evaluation of the vascularity of the callus in predicting normal or delayed healing [11,12].

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Conclusions

Through the intramedullary assembly of the nails, the fracture site is easy to examine by ultrasound, the applicability being demonstrated by the present study, while the possibility of ultrasound monitoring of the fracture focus minimally invasive is another indirect advantage of the surgical technique.

Ultrasound examinations with a high frequency linear transducer allowed me to clearly identify in the first phase the fracture focus, the post-fracture hematoma and the periosteum, then the fibrous callus at 20 days and the bone callus at 30 days, measurable in cross section and longitudinally.

Ultrasound examinations in dynamics corresponded to the histological phases of bone healing, the Doppler Effect faithfully capturing the neovascularization phases, respectively their appearance, progression and regression. The values of the resistance index of the neoformation vessels adjacent to the fracture site confirmed the neovascularization phases by the evolution of the values during the examinations. The values recorded were directly dependent on the time of examination, the segment examined and the age of the patient, explaining the variation of the values of the vascular resistance index during the examinations.

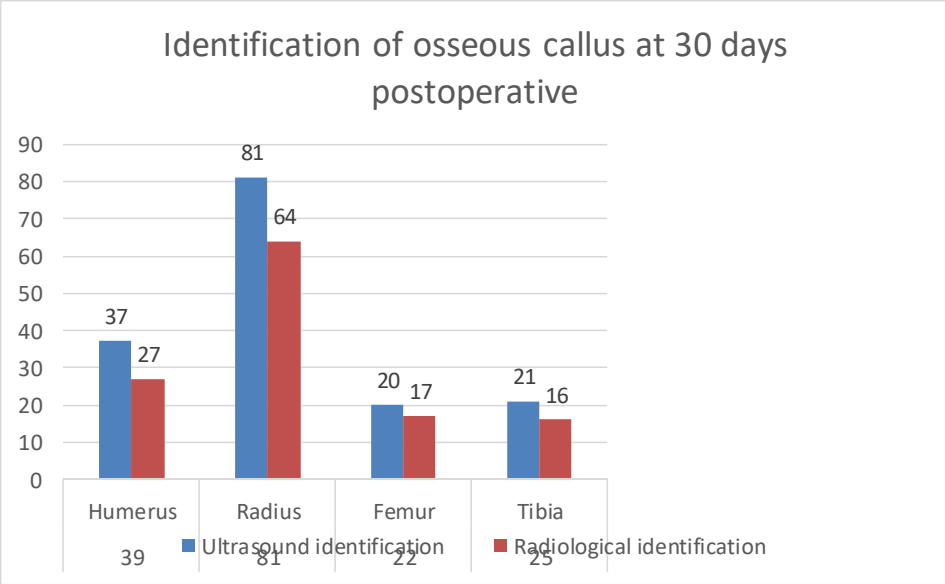

Fig. 1. Comparative identification of the osseous callus by the two imaging methods

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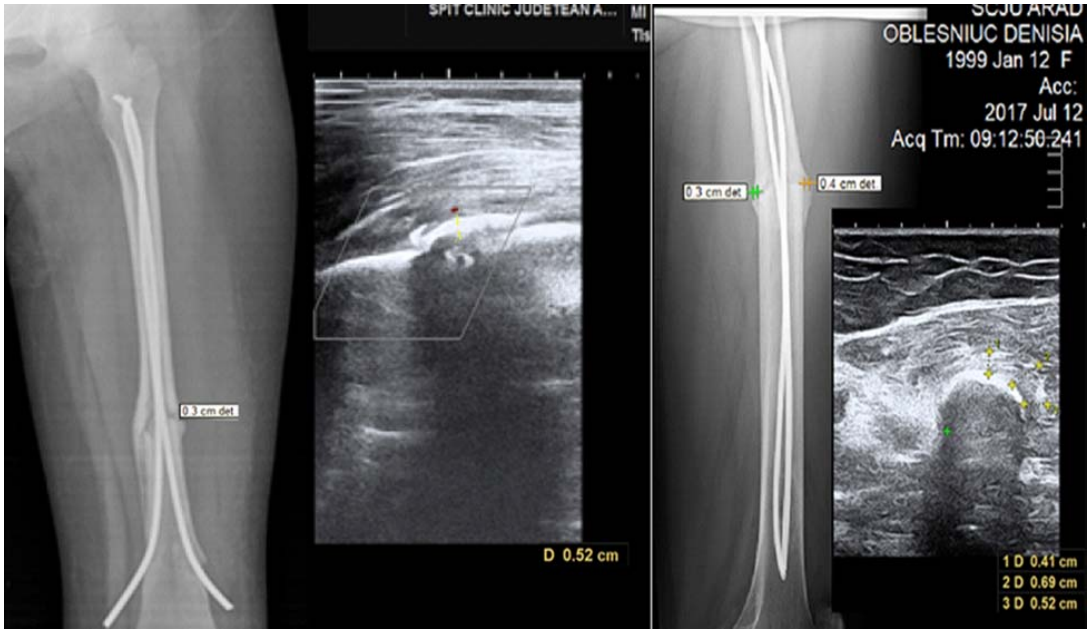

Fig. 2. Comparative radiological imaging aspects (AP and LL incidence) and ultrasound (longitudinal and cross section) of the bone callus at 30 days postosteosynthesis with TEN, femoral shaft fractures.

Identifying and measuring the fibrous and bony callus via ultrasound presents a real advantage for monitoring and assessing the progression to healing of a fracture, ultrasound of the fracture focus performed at 30 days identifying callus formation in 95% of cases, compared to radiography that confirmed the presence of callus only in 74% of cases.

Ultrasound examination requires experience, time, tact and collaboration with small patients. This is particularly important in Doppler examinations, where minor movements limb cause artifacts and, implicitly, an erroneous result. The repeatability and dynamics of the ultrasound allows for a more frequent examination of the same patient throughout the healing process. In the presence of clinical signs of favorable evolution, musculoskeletal ultrasound is a non-invasive imaging method, safe and can be used to monitor the healing of a fracture.

Knowledge of the peculiarities of immature bone and the physiological process of fracture healing in children, knowledge of minimally invasive osteosynthesis technique with elastic titanium rods, radiological and ultrasound evolution of the fracture site, gives the pediatric orthopedist the chance to ultrasound monitor the evolution of the healing fracture, provided that the relevant knowledge of musculoskeletal ultrasound is assimilated.

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PERITONITIS IN CHILDREN. EPIDEMIOLOGICAL, CLINICAL AND THERAPEUTICAL STUDY

Adrian Surd[1], Dan Gheban[2], Aurel Mironescu [3], Cornel Aldea [4], Horatiu Gocan[1], Maria Forssén[1]

Abstract

Introduction. The acute peritonitis is defined as the aggressive and diffuse inflammation of the peritoneum, of bacterial or chemical origin. Classification of peritonitis: primary, secondary (most common) and tertiary. Secondary peritonitis prognosis depends on: etiology, how fast the treatment is initiated, the age of the patient and the presence of associated pathologies. The objective of our study is to determine the frequency, epidemiological, clinical, paraclinical and etiological aspects of acute peritonitis and to evaluate the treatment quality in the Pediatric Surgery and Orthopedics Department of the Clinical Emergency Hospital for Children, Cluj-Napoca between October 2011 and October 2018.Material and methods: This study is a prospective one comprising 340 cases of acute localized or generalized peritonitis. The patients were hospitalized in the Pediatric Surgical Department of the Clinical Emergency Hospital for Children Cluj-Napoca, in a period of 4 years (October 2011 – October 2018).Inclusion criteria were represented by the clinical, imagistic and hematological documented peritonitis. Results: The most frequent cases of peritonitis were represented by appendicular peritonitis with an overwhelming proportion that agrees with literature data. On second place is the necrotizing enterocolitis. This is due to the addressability in the Pediatric Surgical Clinic on one hand and probably to the fact that premature patients are treated in county hospitals without logistic means or trained personnel. Post-traumatic peritonitis and peritonitis after peritoneal dialysis were on third place. Continuing our study we have observed that the post-operative peritonitis, pelviperitonitis, meconium peritonitis, peritonitis after Meckel diverticula, Crohn disease, intussusception, strangulated hernia, volvulus, perforated ulcer are much rarer. Based on where the lesion is located, the vast majority of peritonitis are originated from the submezocolical region and the most commonly perforated organ is the appendix. Discussion. In our study, the frequency of peritonitis was 12,4% of all surgical emergencies the average age was 7,8 years. Pain was the main symptom 191 of the patients having localized pain and 149 patients had diffuse pain. Vomiting was reported in 231(68%) patients and constipation or diarrhea in 83(24,4) patients. Regarding physical signs fever was present in 235 patient representing 69,11% of all patients. Abdominal ultrasound and plain abdominal X-ray were the main imagistic methods of investigations. Preoperative resuscitation is paramount in the treatment of peritonitis in children. Analgesia, nutritional support and sometimes even transfusion are critical in the treatment result improvement. Percutaneous drainage is an option in localized fluid collections but in generalized peritonitis abdominal lavage with warm saline a drainage are always indicated. In our study we noticed that most of the patients in which we used targeted lavage with a rectal tube, the rate of complications improved. Basically we used a small rectal tube (10-16 Fr) which we oriented in all intraabdominal zones with difficult access like pelvic regions, sub hepatic and sub diaphragmatic regions. We used a Guyon syringe to wash the abdominal cavity trough the rectal tube. This proved to be very efficient in avoiding infectious and obstructive complications. in intraabdominal infections. It is given daily in one dose and it is a good therapeutic option for patients that are allergic to penicillin and beta-lactam antibiotics. Moxifloxacin does not require dose adjustment in patients with impaired renal function, giving clinicians a monotherapeutic option in the treatment of complicated IAI. Conclusions: The patient with generalized acute peritonitis corresponds to a particular epidemiological profile related to: low socio-economical level, young age, male gender and pathological background.

Keywords: peritonitis, children, etiology

Introduction

The acute peritonitis is defined as the aggressive and diffuse inflammation of the peritoneum, of bacterial or chemical origin. Classification of peritonitis: primary, secondary (most common) and tertiary.

The peritonitis is a major emergency that needs hospitalization and urgent treatment. Although the mortality due to intra-abdominal infection is reduced, there is almost no progress in this domain recently. High rates of mortality are found in new born with necrotizing enterocolitis or peritonitis due to malformations of the gastrointestinal tract.

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Secondary peritonitis prognosis depends on: etiology, how fast the treatment is initiated, the age of the patient and the presence of associated pathologies. High rates of mortality are found in postoperative peritonitis compared to secondary peritonitis (appendicitis, after Meckel diverticulitis etc.)[1].Peritonitis causes circulatory failure associated with shock, septic state with metabolic acidosis, multiple organ failure and ileus.

The treatment in this pathology involves resuscitation measures, surgical treatment of the source of intraperitoneal infection and adequate and prolonged antibiotic therapy.

The objective of our study is to determine the frequency, epidemiological, clinical, paraclinical and etiological aspects of acute peritonitis and to evaluate the treatment quality in the Pediatric Surgery and Orthopedics Section of the Clinical Emergency Hospital for Children, Cluj-Napoca between October 2011 and October 2018.

Material and methods

Study type

This study is a prospective one comprising 340 cases of acute localized or generalized peritonitis. The patients were hospitalized in the Pediatric Surgical Section of the Clinical Emergency Hospital for Children Cluj-Napoca, in a period of 4 years (October 2011 – October 2018).

Study location

The patients were admitted to the Pediatric Surgical Department either through the Emergency Reception Unit, or from other university clinics or county hospitals.

Study population

All patients between 0 and 18 years of age admitted in the Pediatric Surgical Section with the diagnosis of acute peritonitis based on clinical and paraclinical criteria were included in this study.

Data

To carry out the study, patient record were created (annex 1), where the investigator noted: identity, antecedents, clinical sings, paraclinical data, the received treatment and the outcome of the patients.

Data analysis

Statistical analysis was performed by simple descriptive methods consisting of calculating means and intervals for quantities variables, and percentages for qualitative variables.

Ethical considerations

The respect for the anonymity and the confidentiality of the patient data were both taken into account when the data was collected. All patients signed an informed consent.

Results

Epidemiology

a) Frequency: In our study, acute peritonitis accounted 12.4% of surgical abdominal emergencies, occupying second place after acute appendicitis.

b) Sex: The male gender was predominant, with 201 cases, representing 59.11% and 139 female cases, representing 40.89%. The sex ratio was 1.44 M/F (Fig. 1)

c) Age: The age of the patients ranged from 1 day to 18 years, with an average of 7.8 years. The age group most commonly affected was between 6 and 12 years.

d) Antecedents: Chronic abdominal pain was detected in 28 patients, accounting 8.23% of the total patients and 13.40% of the 177 total patients with appendicular peritonitis.

Other antecedent conditions:

- 7 patients with congenital cardio-vascular disorders
- 5 patients with bronchopulmonary disease
- 18 patients with chronic kidney disease and peritoneal dialysis
- 4 patients with inflammatory bowel disease
- 2 diabetic treated patients
- 3 patients with gastric ulcer
- 1 case of treated pulmonary tuberculosis
- Facilitating factors:

Among the contributing factors are the living standard and leak of education. Other factors were abdominal trauma, low immunological status, cortisone treatment, appendicitis, diverticulitis, recent surgical treatment, peritoneal dialysis.

Clinical data

a) Functional signs:

Pain: a constant sign found at all patients. The pain was located in the epigastric or right iliac fossa in 191 patients, representing 56.18% of cases and generalized in 149 cases, representing 43.82%.

Vomiting: variable in quantity and appearance. Was reported in 231 patients, representing 68% of the cases.

Transit disorders: Fecal transit disorders was present in 83 cases (24.41%). Complete stopping of intestinal transit was reported in 31 cases, representing 9.11% of the cases. There were also 28 cases with rectal bleeding.

Associated clinical signs: besides pain, vomiting and transit disorders, other signs were detected in 43 patients, representing 12.64%.

Time interval between onset of symptoms and consultation: it varied between 2 hours and 2 weeks, according to anamnesis.

b) Physical signs:

Fever: fever was reported in 235 cases, representing 69.11% of the cases.179 patients (76.17%) were represented by appendicular peritonitis and 161 cases had a temperature below 38.5 °C. (Fig. 2)

Abdominal pain: abdominal contracture was reported in 181 cases (53.23%). Generalized muscular defense was detected in 94 cases (27.65%). Abdominal sensitivity was reported at 61 patients, representing 17.94% and in 4 cases (1.18%) the abdominal palpation was without particular features (see table 1).

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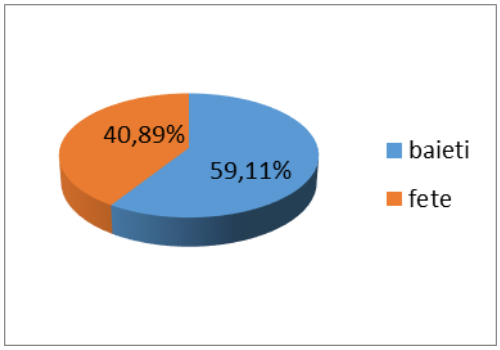

Fig. 1. Sex repartition

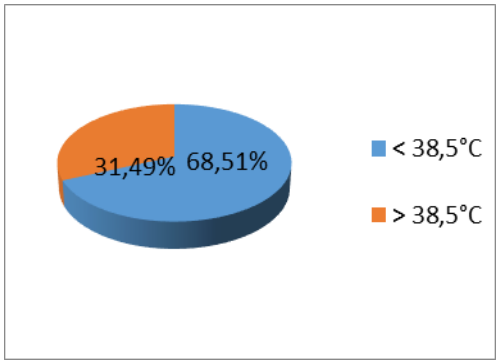

Fig. 2. Temperature (°C) repartition

Table 1. Abdominal pain pattern

Abdominal palpation	No of cases	Percentage
Abdominal contracture	181	53,23%
General muscular defense	94	27,65%
Abdominal sensivity	61	17,94%
Abdominal palpation without particular features	4	1,18%

Table2. Etiology of peritonitis

Etiology	Number of cases	Percentage
Appendicular peritonitis	209	61,47%
Necrotizing enterocolitis	35	10,29%
Post-operative peritonitis	14	4,12%
Post-traumatic peritonitis	26	7,65%
Peritonitis after peritoneal dialysis	26	7,65%
Peritonitis after intussusception	3	0,88%
Peritonitis after Meckel diverticulum	4	1,18%
Pelviperitonitis	6	1,76%
Peritonitis after perforated gastric ulcer	3	0,88%
Peritonitis after strangulated hernia	2	0,59%
Meconium peritonitis	5	1,47%
Peritonitis after Crohn disease	4	1,18%
Peritonitis after volvulus	3	0,88%
TOTAL	340	100%

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Paraclinical data

a) Abdominal X-Ray:

148 patients had an abdominal or thoraco-abdominal X-Ray done. Pneumoperitoneum was detected in 43 cases, representing 29.05% of the patients. Hydroaeric levels was found in 32 cases (21.62%) and intestinal pneumatosis was detected in 14 cases, representing 9.45% of the patients (all affected by necrotizing enterocolitis). In the remaining 59 patients, representing 39.86 of cases, the radiological examination showed no changes.

b) Abdominal ultrasonography:

Abdominal ultrasonography was performed in 324 cases, representing 95.29% of the total number of patients and at all patients with appendicular peritonitis. In 281 cases (82.64%) this procedure detected variable peritoneal collections variable in localization and appearance. Of the patients with appendicular peritonitis, 130 cases presented intraabdominal collections, 28 patients showed suggestive signs of acute appendicitis, 12 patients had an abscess in the right iliac fossa and 7 cases were without particular ultrasonography changes.

c) Abdominal CT:

Only 12 patients with post-traumatic peritonitis benefited from an abdominal CT.

d) Hemoleucogram:

The hemoleucogram was performed in all patients. In 28 patients, representing 8,24% of the cases, the leukocyte formula was normal or had leukopenia. In 198 patients (58,24%) the leukocyte number was between 11,000 and 15,000/µl. 71 patients (20, 88%) had the number of leukocytes between 15,000 and 20,000/µl. The other 43 patients (12,65%) had leukocytosis with values over 20,000/µl.

e) C-reactive protein:

CRP was performed in all patients. 20 patients(5,88%) had values of under 0,5 mg/dl. 81 patients(23,82%) had values of the CRP between 0,5 and 5mg/dl. 123 patients(36,18%) had values between 5 and 10 mg/dl. The remaining 116(34,12%) patients had values of the CRP over 10mg/dl. As we will find during the CRP study, along with procalcitonin, the CRP has predictive value in terms of morbidity associated with peritonitis in infants. Procalcitonin was collected in 98 patients, representing 28.82% of the patients.

Etiological data

In our study, the diagnosis of peritonitis was based on anamnestic data, clinical and paraclinical data and on exploratory laparotomy.

The most frequent cases of peritonitis were represented by appendicular peritonitis with an overwhelming proportion that agrees with literature data. On second place is the necrotizing enterocolitis. This is due to the addressability in the Pediatric Surgical Clinic on one hand and probably to the fact that premature patients are treated in county hospitals without logistic means or trained personnel. Post-traumatic peritonitis and peritonitis after peritoneal dialysis were on third place. Continuing our study we have observed that the post-operative peritonitis, pelviperitonitis, meconium peritonitis, peritonitis after Meckel diverticula, Crohn disease, intussusception, strangulated hernia, volvulus, perforated ulcer are much rarer. Based on where the lesion is located, the vast majority of peritonitis are originated from the submezocolical region and the most commonly perforated organ is the appendix. (Table 2)

Therapeutically approach

a) Preoperative care:

Initial treatment consisted in peripheral venous catheterization for hydroelectrolytic and acid-base rebalancing. All newborns as well as patients requiring parenteral nutrition benefited from the installation of a central venous catheter. Patients that associated occlusive syndrome and those surgically treated immediately after admission in the hospital benefited from the installation of a naso-gastric probe.

b) Medical treatment:

Antibiotics: antibiotic treatment was initiated either preoperatively or at the induction of anesthesia, being continued between 5 to 21 days postoperatively.

Out of 340 patients, 79(23.24%) patients were treated with a single broad-spectrum microbial agent (beta-lactamase inhibitor), 91(26.76%) patients had dual therapy (beta-lactamase inhibitor/cephalosporin and macrolide) and 170 patients (50%) benefited from triple antibiotic combination (cefuroxime, clindamycin and metronidazole). All patients with antibiotic treatment that lasted more than 5 days have been also treated with an antifungal agent.

Antalgic treatment: all patients were given antalgic treatment during hospitalization and also at discharge (between 0 and 10 days).

Nutritional support: patients who were unable to feed in the first postoperative days benefited from parenteral nutrition, usually with Aminovem, together with glucose, electrolytes and vitamins. Probiotics (Lactobacillus and Bifidobacterium) were also given to newborns, especially at those with necrotizing enterocolitis.

Blood transfusion: patients with severe septic shock or associated hemorrhagic shock, as well as those with severe thrombocytopenia received whole blood, plasma or platet mass. A total of 31 patients (9.12%) have had transfusions.

c) Surgical treatment:

All patients from our study have undergone surgical treatment, except for the patients with peritonitis associated with peritoneal dialysis.

Peritonitis treatment:

Depending on the preoperative diagnosis, peritonitis treatment required surgical approach either through the right iliac fossa, or median approach if it was necessary to explore the whole peritoneal cavity. The peritoneal liquid was collected for laboratory samples and then evacuated, as well as abundant washing of the peritoneal cavity until clear fluid was highlighted was made. After the surgery, one or two peritoneal drainage tubes were installed.

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Table 3. Most common intraabdominal lesions

Lesion	Number of cases	Percentage	Therapeutically gesture
Small intestine rupture	6 cases	30%	Intestinal suture/Bowel segmental resection and anastomosis
Liver rupture	3 cases	15%	Hepatoraphy
Splenic rupture	6 cases	30%	Splenoraphy/Splenectomy
Pancreatic rupture	3 cases	15%	Drainage/Suture
Renal rupture	2 cases	10%	Suture of the kidney and bassinet

Table 4. Patients outcome

Evolution		**Number**	**Percentage**
Favorable		**252**	**74,12%**
Complications	**Intraabdominal abscess**	**8**	**2,35%**
	Deep-wound infections	**16**	**4,70%**
	Superficial wound infections	**25**	**7,35%**
	Sepsis with resistant germs	**14**	**4,12%**
	Pneumopaty	**2**	**0,60**
Mortality		**23**	**6,76%**
Total		**340**	**100%**

Peritoneal fluid:

The peritoneal fluid was purulent in 281 cases, representing 82.65% of the patients. Hemoperitoneum was present in 24 cases (7.06%). The visceral peritoneum was most often inflamed and false membranes were found in 168 patients, representing 49.41%.

The digestive and bile fluid was found in 9, respectively 4 cases.

d) Etiological treatment:

Appendicular peritonitis: direct or retrograde appendectomy was performed at all patients with appendicular peritonitis. In 61 cases (29.19%) out of 209 patients direct appendectomy was performed and retrograde appendectomy was performed at 148 patients (70.81%). Also, lavage with minimum 2l of warm serum and Douglas or right latero-colical space drainage was performed.

Necrotizing enterocolitis: in 27 cases (77.14%) out of 35 patients, exploratory laparotomy was performed and in 8(22.86%) cases, percutaneous drainage of the peritoneal cavity. Of the patients with laparotomy, 6 patients underwent enteropathy and drainage, 19 underwent segmental resection of the intestine and ileostomy/colostomy and drainage and 2 patients underwent ileostomy and drainage.

Peritonitis through perforated ulcer: All patients underwent suture of the gastric wall and filling with omentum and drainage.

Peritonitis after Meckel diverticulum: Patients with peritonitis after Meckel diverticulum have had segmental ileum resection, lavage and drainage.

Post-traumatic peritonitis: of the post-traumatic peritonitis 20(76.92%) patients had closed abdominal trauma and 6 patients (23.08%) had open abdominal trauma. Of the patients with open abdominal trauma, 4 cases had small bowel lesions, one patient had stomach

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lesion and other patient had a colon lesion. These patients underwent lesion sutures, lavage and drainage. (Table 3)

Pelviperitonitis: patients with pelviperitonitis due to piosalpinx have benefited for abscess evacuation and peritoneal drainage.

Postoperative peritonitis: in 10 (71.43%) out of 14 patients the cause was the dehiscence of the ileo-colic, ileo-ileal or jejuno-ileal anastomosis. In 4 patients the cause of the peritonitis could not be detected. Peritonitis after intussusception, strangulated hernia or intestinal volvulus were treated with segmental resection of the ileon or ileon and right colon and ileo-ileal or ileo-colic anastomosis.

Outcome

a) Mortality:

In our study there were 23 deaths, representing 6.67% of the cases. 18 deaths occurred at infants with necrotizing enterocolitis, 1 death in a patient with meconium peritonitis and septic shock, 2 deaths in patients with postoperative peritonitis, septic shock and multiple organ failure and 2 deaths in polytrauma patients.

b) Morbidity:

Postoperative evolution was favorable in most cases. Postoperative complications occurred in 65 cases, representing 19.12% of the patients. 8 patients developed intraabdominal abscesses, 16 patients developed abdominal wall infections, 14 cases with septic state due to nosocomial infections and 2 patients presented pneumopathy. (Table 4)

c) Postoperative evolution:

252 patients, representing 74.12% of the cases had a good postoperative evolution, the intestinal transit resumed after an average of 3 days and the nasogastric probe (at those who needed installation) was suppressed in the 4-th day after surgery.

d) Hospitalization period:

The hospitalization period was between 5 and 27 days, with an average of 6 days of hospitalization.

e) Medium/long term outcome:

5 patients developed occlusive syndrome in 1 to 4 months after the surgery. 1 patient was treated conservatively with gas tube and nasogastric probe. In 4 patients surgery was performed with adesiolysis and clamp resection with favorable outcome.

Discussion

Peritonitis remains the main surgical abdominal emergency in children. Most of the children are diagnosed with some delay, hence the increased frequency of peritonitis. In our study, the frequency of peritonitis was 12,4% of all surgical emergencies the average age was 7,8 years. Pain was the main symptom 191 of the patients having localized pain and 149 patients had diffuse pain. Vomiting was reported in 231(68%) patients and constipation or diarrhea in 83(24,4) patients. Regarding physical signs fever was present in 235 patient representing 69,11% of all patients. Abdominal ultrasound and plain abdominal X-ray were the main imagistic methods of investigations. Preoperative resuscitation is paramount in the treatment of peritonitis in children. Analgesia, nutritional support and sometimes even transfusion are critical in the treatment result improvement. Percutaneous drainage is an option in localized fluid collections but in generalized peritonitis abdominal lavage with warm saline a drainage are always indicated. In our study we noticed that most of the patients in which we used targeted lavage with a rectal tube, the rate of complications improved. Basically we used a small rectal tube (10-16 Fr) which we oriented in all intraabdominal zones with difficult access like pelvic regions, sub hepatic and sub diaphragmatic regions. We used a Guyon syringe to wash the abdominal cavity trough the rectal tube. This proved to be very efficient in avoiding infectious and obstructive complications. Recently, little therapeutic progress has been made in the treatment of intra-abdominal infections. Regarding the antibiotic treatment, more and more antibiotics have been used, which is outstanding, but two molecules in particular prove of interest to us. Ertapenem is a carbapenem antibiotic with broad spectrum, resistant to beta-lactamase activity, but not as efficient against pseudomonas aeruginosa as imipenem and Meropenem. It is not used in any infections with pseudomonas aeruginosa. [2].Moxifloxacin has good peritoneum and gastrointestinal tract penetration and has been shown to be equally effective as levofloxacin combined with metronidazole in intraabdominal infections. It is given daily in one dose and it is a good therapeutic option for patients that are allergic to penicillin and beta-lactam antibiotics. Moxifloxacin does not require dose adjustment in patients with impaired renal function, giving clinicians a monotherapeutic option in the treatment of complicated IAI. [3]

Conclusions

Generalized acute peritonitis is defined as a severe and diffuse inflammation of the peritoneum, of bacterial or chemical origin. It represents a vital surgical emergency that requires hospitalization and urgent treatment.

This retrospective study on the 340 patients with generalized acute peritonitis allowed us to draw some important conclusions, regarding the objectives of the study:

- Generalized acute peritonitis occupies a special place in the abdominal emergencies in children by frequency and severity.
- The patient with generalized acute peritonitis corresponds to a particular epidemiological profile related to: low socio-economical level, young age, male gender and pathological background.
- The etiology of peritonitis remains varied, but are dominated by appendicular peritonitis.
- The prognostic of peritonitis depends on etiology, precociousness of diagnosis and treatment, age and associated conditions.

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CONGENITAL SPIGELIAN HERNIA IN CHILDREN – CASE REPORT

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Abstract

Spigelian hernia is an uncommon entity in children. The clinical signs can lead to a misdiagnose with inguinal hernias. In the literature there are only a few references to this kind of pathology. Usually these hernias associate cryptorchidism.

We report a 2-years-old boy with bilateral Spigelian hernia, bilateral undescended testis and hypospadias with penile curvature. The Spigelian hernias were repaired and bilateral orchidopexy was done after 3 months period. Hypospadias repair was done afterwards.

Keywords: Spiegel hernia, Abdominal wall defect, Congenital, Undescended testis, Children

Introduction

A Spigelian hernia is very rare and accounts for only 1.5% of the abdominal hernias in the population [1]. This condition is even rarer in childhood and can be often misdiagnosed with an inguinal hernia [2,3], due to the different aspects in presentation, like size, location and symptoms [2–5].

Spiegel hernia is situated on the ventral side of the abdominal wall adjacent to the semilunar line. Adriaan van der Spiegel was the first to describe the semilunar line in 1645. But in 1764 Klinkosch [6] described a spontaneous lateral ventral hernia located in the semilunar line. The first who described this ventral hernia in a child was Scopinaro [7] in 1935.

Only about 70 cases were published until now in the literature [8]. In a review between 1935 and 2000 there have been only 37 cases reported in children [9]. These hernias are more frequent in males than females (ratio, 3.7:1), and they are more commonly on the left and may occur bilaterally in 15% of cases [10]. The majority of male patients associate cryptorchidism [11].

Purpose

Congenital Spigelian hernia are rarely seen in children. There are only few cases reported in the literature (about 35 cases) [1-3]. We report a male child with this rare condition managed successfully. He also had associated bilateral cryptorchidism and hypospadias with penile curvature.

Material and method

The case we want to present is a 2 years old male child with a bilateral Spigelian hernia, bilateral cryptorchidism, hypospadias and penile curvature. The case may be considered one with multiple pathologies which were treated sequentially with different types of surgical interventions.

Results

The child had a presentation in the pediatric surgical ambulatory department at the age of ten months were he was diagnosed with Spigelian hernia (fig. 1), bilateral cryptorchidism and hypospadias with penile curvature. After excessive crying and coughing, there were to bulges on the anterolateral abdominal wall.

The ultrasonogram showed a bilateral hernia sac that could be reduced by hand. Ultrasonography didn't have a major role in the diagnosis.

The child underwent surgery for the bilateral repair of anterior abdominal wall by open technique (figs. 2 & 3). The weakness found in the transversalis fascia was sutured bilaterally.

Then, after about three months a right orchidopexy was done and after another three months he underwent left orchidopexy. The spermatic cords were long enough to allow a normal testicular descent and lengthening was not required. The patent processes vaginalis was closed. The testis were hypertrophic, with abnormal epididymis and absence of the gubernaculum.

None of the two defects had recurrences and both testis were successfully present in the scrotum. The one stage intervention for hypospadias with urethroplasty and penile curvature repair was done at the age of two years with no complications.

In the literature the authors divide the Spigelian hernias in two categories based on site of origin of the sac: the ones with cryptorchidism the sac is originating from Spigelian fascia inferomedial to inferior epigastric vessels (low Spigelian hernias), the ones without cryptorchidism and female patients have hernia sac arising from the Spigelian belt superolateral to the inferior epigastric vessels (high Spigelian hernias) [12,13]. Brendan's hypothesis sustain that in low Spigelian hernia the testis has an ectopic location and is maldescended [14].

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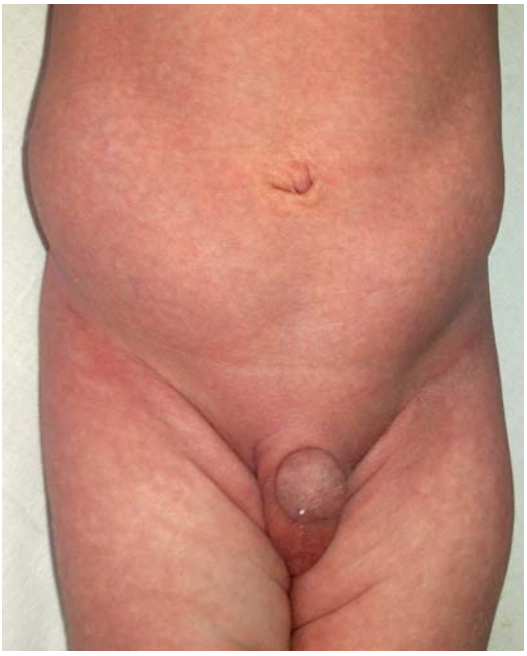

Fig. 1. Bilateral Spigelian hernia shows like two lumps in the anterolateral abdominal wall

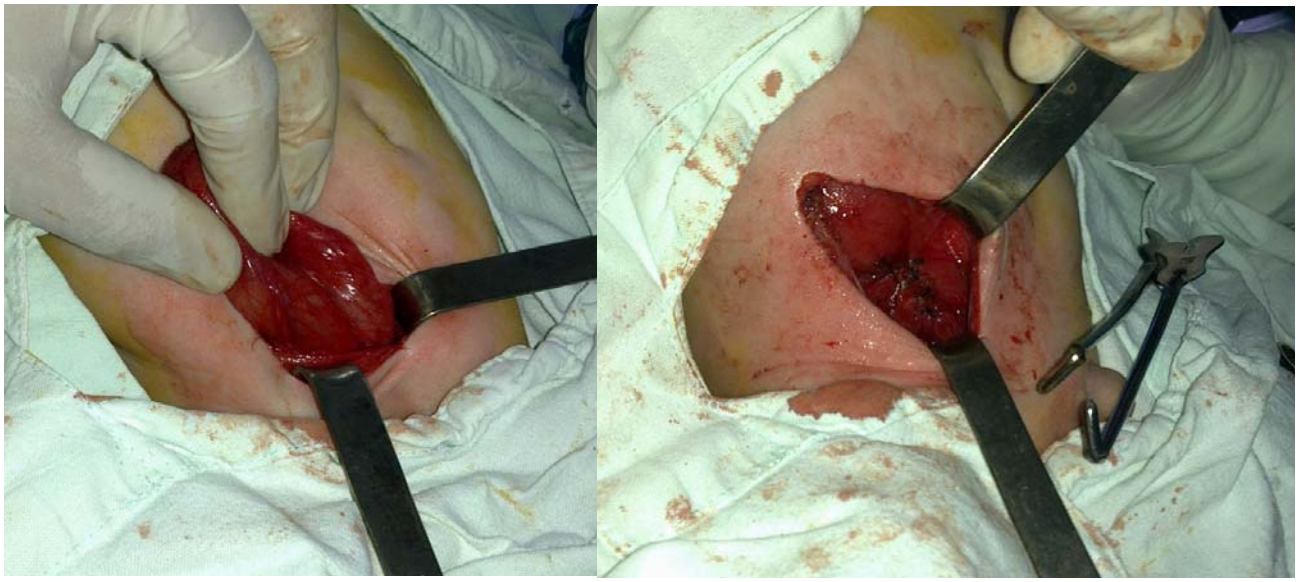

Fig.2 & 3. Spigelian hernia sac and suture of the weakness in the transversalis fascia

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Conclusions

Our case presented a high located weakness found in the transversalis fascia with a not well-defined sac, bilaterally, which was treated by hernioraphy. Concomitant the patient had cryptorchidism with a patent processes vaginalis treated successfully by bilateral orchidopexy, after a three months period.

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COMPLICATION AFTER MINIMAL INVASIVE REPAIR OF PECTUS EXCAVATUM

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Abstract

Background: Minimal invasive repair of Pectus Excavatum (MIRPE) has now become the main therapeutic method for Pectus Excavatum (PE) in children. This study focuses on our experience with MIRPE with special emphasis on the complication of the surgical procedure. Methods: Since 2007 we have performed 33 minimal invasive repairs of PE. The surgical technique was the standard MIRPE technique with the modifications we have previously described. Results: We had no intraoperative accidents and no fatalities. Postoperative complications occurred in 8 of the 33 cases. Most of the complications (4 cases) were wound-related, with dehiscence or infection. Postoperative pleural effusions occurred in 3 patients, pneumothorax in 1 case and pericarditis in 1 case. All the complications occurred within 4 weeks from the surgical intervention. Reoperations were necessary in 2 cases, all of them for closing the dehiscent surgical wound. We had no bar shifts. The bar was removed in 20 patients after a period ranging from 1 to 3 years. Conclusion: Our results are comparable with those of the early reports of this technique and are subject to continuous improvement.

Keywords: Pectus Excavatum, minimal invasive repair, surgical treatment, complications, outcome, healthcare quality

Introduction

More than two decades after it was first performed and one decade after the first reports about the procedure were published, minimal invasive repair of Pectus Excavatum (MIRPE) has now become the main therapeutic method for Pectus Excavatum (PE) in children (1). Even though there is no consensus regarding the origin of the disease, there is consensus over the treatment of the disease and the benefits of the minimal invasive approach: less trauma to the tissue, and tiny, almost negligible, postoperative scarring on the skin. Several studies have concluded that there are real benefits for the patients that underwent repair of the chest deformity, in terms of cardio-vascular function, release of the symptoms, esthetics and body image (2, 3, 4, 5, 6). Various improvements and modification of the technique, as well as reports of the results, are published every year all over the world. Along with the learning curve and improvement of the technique complication rates have decreased gradually: from 12% in the first decade to 1% in the second decade (4, 7). Severe complications like bare shift, heart trauma, pleurisy or pericarditis occur now in less than 1% of the patients (4).

In 2007 we were the first surgical team composed exclusively of Romanian doctors to perform this type of surgical intervention, and we reported our preliminary results in 2010 (6). Since then MIRPE has become the standard surgical procedure in our departments. A comprehensive analysis of our experience with both opened and minimal invasive repair of PE in children reveals, without doubt, the superiority of the latter in both safety and outcomes of the treatment (9).

This study focuses on our experience with MIRPE with special emphasis on the complication of the surgical procedure.

Material and method

Since 2007 we have performed 33 minimal invasive repairs of PE. Our patients were 6 girls and 27 boys. The age of the patients ranged between 8 and 20 years, with a median of 15.2 years. One patient was less than 12 years old (8 years) at the time of the operation. The deformity was symmetric in 17 (5%) patients. Symptoms were present in 21 patients (63.6%), effort dyspnea in 20 cases and recurrent chest pain in 2 patients. In 2 cases (10%) palpitations were associated to effort dyspnea. Clinical exam revealed different degrees of alteration of the cardiac function of in 18 patients (54.5%). In 5 (15%) patients Marfan syndrome was also present. In one case, a 19 years old female, the deformity reoccurred after a previous Ravitch correction of PE at the age of 6. The surgical technique was the standard MIRPE technique with the modifications we have previously described, Nicodin et al. 2010 (8).

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Table 1. Postoperative complications

Complications	**No. of patients**
Wound dehiscence/ infections	4
Pleural effusions	3
Pneumothorax	1
Pericarditis	1
Bar shift	0
Reoperation	5
Overall complications	8

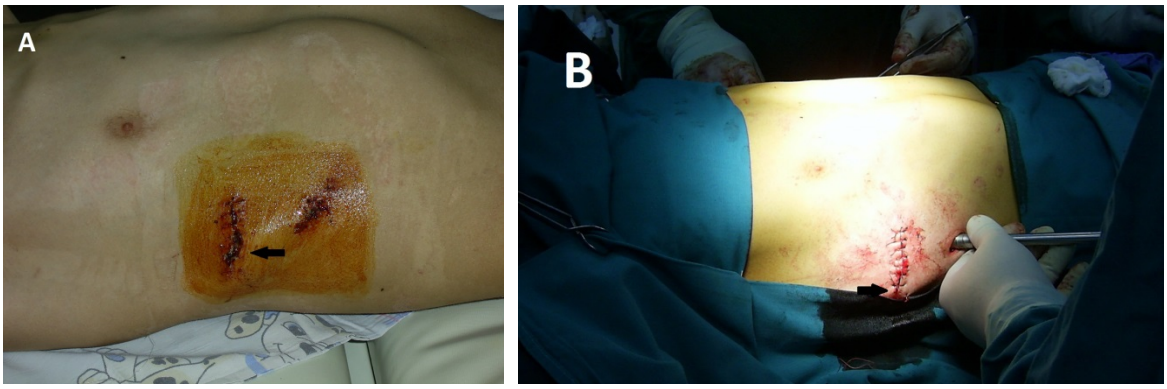

Fig. 1. A. Partial dehiscence of the surgical wound, 14 days after surgery in a 14 years old boy with Marfan syndrome; note the elevation of the skin produced by the insufficient bending of the end of the bar. **B**. Same patient at the end of the surgical intervention

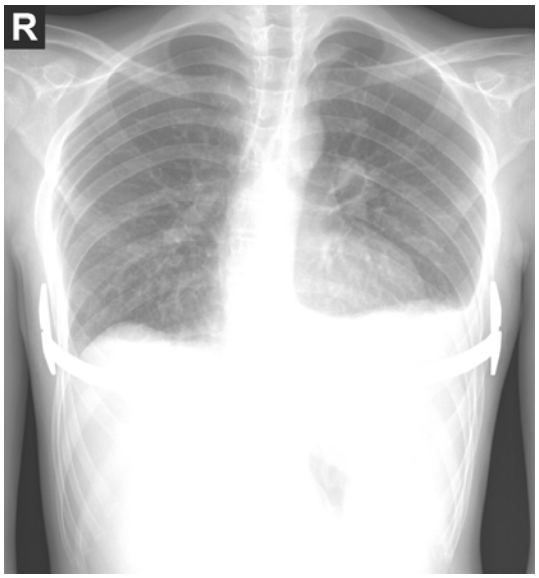

Fig. 2. Postoperative pleural effusion 14 days from surgery

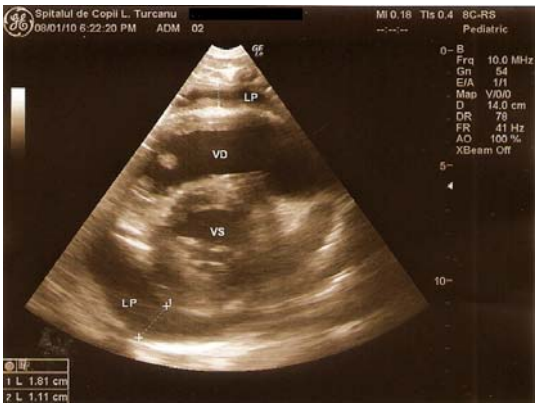

Fig. 3. Image of the cardiac ultrasound of 15 years old boy with pericarditis

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Results

The operative time ranged from 60 to 120 minutes with a median of 71.5 minutes. Hospital stay ranged from 6 to 40 days, mean 12 days. We had no intraoperative accidents. We used postoperative pleural drain in 26 of the cases, 25 unilateral and one bilateral. The pleural drain was kept in place for a mean of 3.69 days (1-14 days). Postoperative complications occurred in 8 of the 33 cases (24.8%) (Table 1). We had no fatalities. Most of the complications (4 cases) were wound-related, with dehiscence or infection. Wound dehiscence was the most prevalent complication in our series, and our observation was that it was related to an insufficient bending of the tip of the Lorenz bar. In the surgical technique we use, we prefer to leave the end of the bar and the lateral stabilizer in the subcutaneous tissue (not sub-muscular) (Fig. 1). Postoperative pleural effusions occurred in 3 patients, in 2 of them spontaneous resolution after conservative treatment occurred and in one case needle aspiration was performed (Fig. 2). In one patient pneumothorax occurred 24 hours after surgery and pleural drainage was necessary.

Pericarditis occurred in one of the cases. It was the most severe complication that we were forced to face (Fig. 3). The complication occurred during the first week after surgery. We performed a pericardial puncture, and the aspirated liquid was cultured. The patient received both antibiotic treatment and prolonged anti-inflammatory medications. The pericarditis was slowly relieved, but the patient required prolonged hospitalization (40 days).

All the complications occurred within 4 weeks from the surgical intervention. Reoperations were necessary in 5 cases, 4 for closing the dehiscent surgical wound and 1 pneumothorax drainage. The bar was removed in 20 patients after a period ranging from 1 to 3 years. We had no complications after bar removal.

Discussions

First reports after the introduction of MIRPE in 1998 by Nuss indicated a higher rate of complications for the minimal invasive technique (6). After the early learning experience, complication rate dropped significantly but still lays around 15% (4, 10, 11, 12). The overall complication rate of 24% in our series is still high compared to most other current reports, but it may be compared to the early results of other series reported in literature, even by those who implemented this technique (1).

Wound infections occur in up to 1,5% of the patients and is a major cause of surgical reintervention (13). In our series wound dehiscence and infection was the most prevalent complication. In 4 of these patients we were forced to do a revision of the surgical wound. A direct observation was that in these patients the bar was insufficiently bent with the tip of the bar, resulting in pressure on the wound sutures. In all three cases debridement of the necrotic tissue and secondary closure of the wound was performed. In the following cases we tried to bend the bar a little more so that the tips of the bar would dig in the lateral thoracic wall.

Pleural complications are probably the most common complications after Nuss procedure. Postoperative pneumothorax occurs in up to 7% of the cases, while pleural effusion occurs as high as 3% (10, 11, 12, 14, 15, 16). In our series pneumothorax occurred in 1 of the 33 cases but when analyzing this result we have to consider that in most of the cases (24 out of 33) we used postoperative pleural drainage for at least 24 hours. So 1 out of 7 non-drained cases means approximately 14%. So. it is our belief that, because the patient is immobilized in bed at least for the first 24 hours, a 1 to 2 days passive drainage of the right pleural cavity will permit the evacuation of any residual intrapleural fluids. On the other hand, pleural effusions occurred in 3 cases, and in 1 of them we were forced to perform needle aspiration. All cases went well after treatment, the Pectus bar was kept in place, and nickel allergy may be excluded.

Cardiac or pericardial lesions are probably the most severe complications after MIRPE. Intraoperative accidental heart or pericardial perforation may lead to intraoperative death (17, 18, 19). Fortunately, we have had no such fatal complications. One of the patients developed a pericardial effusion in the first days after surgery. Because nickel allergy couldn't be proved, the cause of the pericardial effusion was probably a pericardial trauma during surgery. The problem was resolved with conservative treatment, without sequelae. Nevertheless, this complication increased significantly the hospital stay up to 40 days and consequently the costs of treatment increased. Perhaps one of the most important features in our series is that we had no bar shift. Bar shift was initial one of the most important postoperative complication in Nuss technique. Initial reports indicated a rate up to 15% (12, 20). The consequent use of the lateral stabilizers reduced this complication to less than 1% (4). We always use lateral stabilizers and suture them tight to the muscular and subcutaneous tissue, and so we were never forced to deal with this category of problem.

Conclusions

The advantages of minimal invasive repair of PE are clear. Nevertheless, together with benefits there are some pitfalls that may overshadow the remarkable results of the treatment. We had an overall complication rate of 24%.

The most prevalent complication was wound related and the most severe was pericarditis. We had no fatalities and no bar shifts. Our results are comparable with those of the early reports of this technique and are subject to continuous improvement.

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AVAILABLE RECONSTRUCTION METHODS OF NERVE INJURIES – A LITERATURE REVIEW

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Abstract

Nerve reconstructive methods include in addition to surgical technique also a close postoperative follow up and a good understanding of nerve regeneration. Direct reconstruction involves the neurorrhaphy of the nerve stumps if they have a proper vascularization and the suture can be done without tension. There are several suturing techniques like end-to-end, end-to-side and side-to-side coaptation. End-to-end neurorrhaphy is the procedure of choice, due to a higher axonal regeneration and better outcomes. When the surgeon faces a major injury with an extensive nerve loss, the reconstruction is made using nerve grafts. The autologous graft has superior results compared to the non-autologous grafts. It has the benefit of being an immunologically inert structure, contains Schwann cells, neutrophic factors and adhesion molecules that help the nerve to regenerate better. Currently the researchers concentrate on the development of a synthetic material that will successfully replace the autologous graft. The substituents are represented by nerve ducts or conduits and cadaveric allografts, which have the advantage of adequate microarchitecture and neurotrophic factors beneficial to axonal regrowth, but require up to 2 years of immunosuppressive therapy. This branch is in a continuous progress, and maybe in the future the patients will benefit from a close-to-ideal synthetic nerve graft to replace the available grafts. Another technique is the nerve transfer that involves the use of a distal nerve branch anastomosed with the injured nerve near the neuromuscular junction in order to transmit a nerve impulse and thus the muscle to resume its function. The results of nerve transfer are promising, being an adjuvant method for patients with unsatisfactory initial results.

Keywords: neurorrhaphy, nerve reconstruction, nerve graft, autograft, nerve transfer, peripheral nerve injury

Introduction

Nowadays, the prevalence of peripheral nerve injuries is increasing, due to the modern traumatic events escalation. They occur more frequently in males and are found in 2.8% of the total number of trauma patients. The annual incidence is about 13 to 23 per 100,000 people per year, affecting especially the upper limb [1,2]. The peripheral nerve lesion has serious implications for the paediatric population, mainly because of the more pronounced psychological impact, but also the different perception of the disease.

Nerve reconstructive techniques have been considerably developed since their first introduction in 1870, mainly due to the advancement of microscopic technology and the better understanding of the pathophysiology of the nerve structure and its lesions [3].

The aim of the study is to emphasize the importance of a suitable treatment every time we face an injury of the nerve. Moreover, a deep understanding of the condition is needed in order to offer the patient an ideal treatment with best outcome in the future. We intend to focus on the available surgical approaches on restoring peripheral nerve integrity after traumatic or iatrogenic transection and to highlight the current problems using the information made available by current studies

Surgical approach

When it comes to nerve laceration, the main surgical objective is the nerve reconstruction, keeping in mind that the full recover of its function is an unpredictable process which depends on a lot of external and internal factors. [4] In the situation of a mixed nerve transection, the sensory and motor fibers should be accordingly aligned for a satisfying recovery in the future. The misconnections will lead to poor results, whereas the sensory fibers develop through the former motor fibers and cannot produce the same effect on the motor end plate of the muscle. [5]

Other variables that influence the functionality of the nerve are the age of the patient, the mechanism of the trauma or how the nerve injury occurred, the type of injury or its location, the distance between the distal end and the proximal end of the nerve, when it comes to a loss of substance but also the elapsed time from the traumatic event to the surgical intervention with curative purpose.

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Nerve reconstruction without grafting

End to end neurorrhaphy is the procedure of choice when the stumps of the nerve are vascularized accordingly and can be sutured without tension [2]. Direct repair, ideally in the first 3 days, consists either of epineural micro sutures with thick alignment between the nerve ends or accurate matching of individual fibers of the nerve [4, 6]. The nerve stumps still contain neurotransmitters within the first 72 hours, and their architecture does not deteriorate during this time, so the ends can be better aligned [6]. The tension free suture with individual connection of the fascicles promotes the nerve healing and have a better axon regeneration at the distal part. Thus, it may ameliorate the long-term recovery [7].

However, the theoretical advantages of the fascicular repair are counterbalanced by a high occurrence of nerve branch damage and scars due to the tissue dissection, conditions which could have an impact on the restoration [2]. Many authors share the belief that the epineural suture presents the same functional results as the fascicular one and there are no significant differences between them [2, 6, 7, 8].

For optimal results, the anastomosis principles must be respected. The surgeon must have an adequate workspace so as to differentiate the damaged structures from the healthy ones. A good nerve dissection is necessary as seen in figure 1. The ends of the traumatized nerve must be trimmed to healthy tissue (Fig. 2), which can be attested by the visualization of the nerve fibers and the dotted bleeding from the edges of the nerve. With careful neurolysis the surgeon separates the nerve from the scar tissue. The suture should not deform the nerve and the nerve fibers should not exit from the plane of the nerve. Postoperatively the part of the body that has undergone the intervention must be immobilized for 4 weeks [6].

End to side and side to side neurorrhaphy are also presented in several clinical trials as convenient surgical techniques for the repair of peripheral nerve damage.

End to side suture consists of the coaptation between the distal end of the injured nerve and the trunk of a nerve located in the proximity. It is described as a good alternative when conventional techniques such as autologous nerve graft or terminal to terminal neurorrhaphy, are not feasible due to large laceration or when the proximal stump of the nerve is unavailable. The cited literature recommends the use of this technique only in selected cases, due to the discrepancy between the clinical results and the experimental studies. It is presumed that because of the end to side anastomosis the axonal growth is diminished and the regenerative process is delayed leading to functional disturbances [9, 10].

A further clinical trial (Tateshita T. et al., 2018) compares the results of end-to-side and end-to-end neurorrhaphy between two nerves of different caliber. The results were analyzed at 6 weeks and 12 weeks after the surgical intervention. The end to end anastomosis revealed a higher rate of axonal regeneration at 6 weeks in the detriment of end-to-side suture. The rate gets even at 12 weeks. This thereby attests the superiority of end-to-end neurorrhaphy due to early axonal regeneration that impedes peripheral muscle atrophy and thus may have a better functional recovery in comparison with the end-to-side neurorrhaphy [11].

Several clinical trials certify the preventive action of side-to-side neurorrhaphy on early muscular atrophy [12, 13]. The anastomosis is performed distally from the initial injury on a nearby nerve trunk that will serve as the donor nerve. A longitudinal incision is made on the epineurium and partially on the adjoining perineurium, and then sutured together side by side. This technique does not damage the donor nerve and facilitate a better motor and sensorial recovery [12, 13].

Rönkkö H. et al. (2016) confirms the superiority of end-to-end anastomosis through an experimental study made on rats. The tibial and peroneal nerve were sectioned and then sutured accordingly. Although the test animals regained their limb functionality, there were notable differences between the side-to-side and end-to-side anastomoses compared to the end-to-end type which had better outcomes in the walking track analysis, superior regeneration of the axons confirmed by histopathological examination and an adequate connection with the muscle fibers [14].

Nerve reconstruction with autologous graft

In case of a major injury with an extensive nerve loss, the use of a nerve graft is needed in order to restore its continuity (Fig. 3). The graft consists either of biosynthetic materials or autologous tissue harvested from the patient. This represents the current standard in peripheral nerve reconstruction, especially when the nerve stumps cannot be approximated to achieve a tension-free suture [15]. The nerve graft meets the standards of an ideal nerve structure because it contains Schwann cells, neurotrophic factors, and adhesion molecules that promote nerve regeneration. Moreover, the autogenous graft is immunologically inert [3]. The graft is selected according to the diameter of the recipient nerve and then interposed between the ends of the injured nerve to restore its continuity. The most commonly used are the sural nerve and the medial cutaneous antebrachial nerve [4].

Autografting has superior results compared to biosynthetic conduits when the nerve gap exceeds 3 centimeters or when the lesion is located proximally on the nerve trunk. After harvesting, the donor graft is reversed and then sutured, which maximizes the regeneration of a larger number of axons through distal canalization (Fig. 4). Graft gathering produces functional disorders at the level of the donor site, therefore a sensitive nerve is usually sacrificed to regain a much more important motor function (Fig. 5). Other complications may be loss of sensitivity in the area served by the donor nerve, scarring and painful neuromas.

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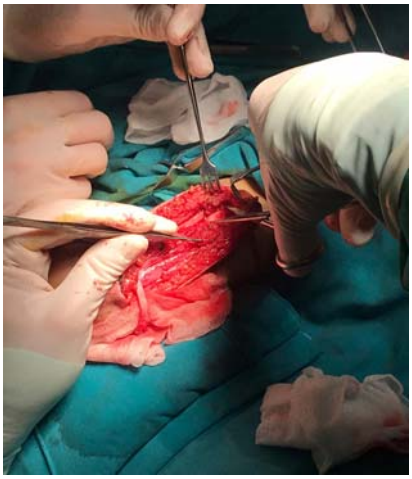

Fig. 1. Nerve dissection

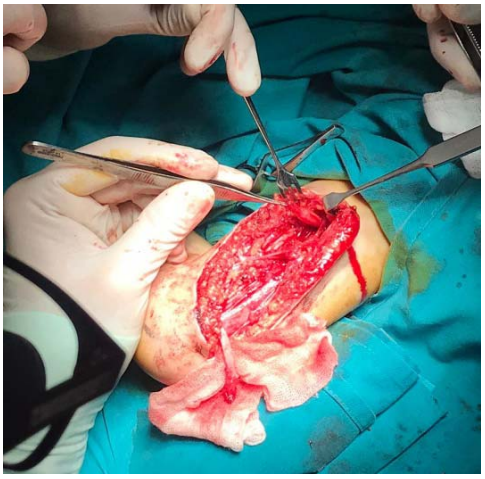

Fig. 2. Proximal stump mobilization

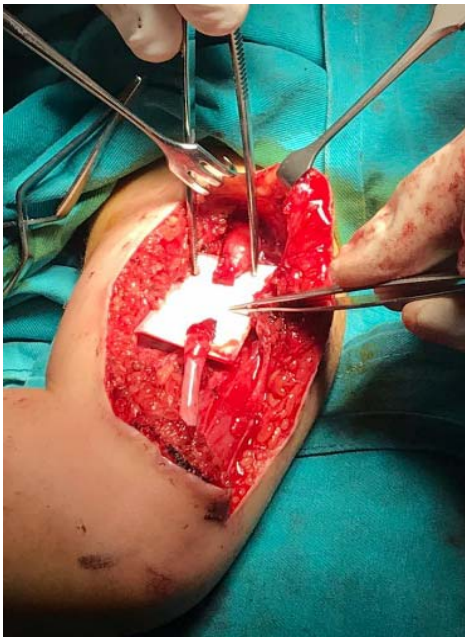

Fig. 3. Proximal and distal nerve ends

At the suture site, improper alignment of nerve fibers, manipulation with surgical instruments as well as suture threads can further traumatize the nerve, thus leading to poor regeneration. It is claimed that 50% of the axons are lost with each anastomosis, so that at a nerve graft with two ends just 25% of the bundles will have the regenerative potential. Usually the nerve graft is 20% longer than the nerve gap. It must be harvested with care just before implantation due to the short survival time of the Schwann cells ex vivo [2].

Gosk J. et al. (2010) compared direct end-to-end anastomosis and nerve graft reconstruction in children who have suffered perinatal brachial plexus injury. The results tend to incline towards the superiority of the direct neurorrhaphy, outcomes supported also by other specialized studies [2, 3, 16]. However, according to Grinsell D. et al. (2014) the autograft is the best option in a nerve gap greater than 3 centimeters. The final result depends on the length of the graft thus a shorter graft under 5, 5 centimeters has good result in 75% of the cases. In contrast to this fact, a longer graft (more than 6 centimeters) has favorable outcomes just in 27% of the cases [17]. Lower success rates of 58% were also reported in the case of proximal radial nerve reconstruction [18].

The results presented in the studies are inconsistent and depend on several factors. Simple lesions usually have good results. Age is an important factor proven in several

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studies that reported better functional outcomes in children than adults. Poor patient compliance with recovery treatment as well as low social and educational status hang as negative prognostic factors and have modest outcomes [6]. The type of nerve damage also matters, the sensory type nerves recover better than the motor ones. The ulnar nerve has often poor outcomes after standard reconstruction [19] and a regenerative potential of motor function lower than the median nerve. The sensory function recovers equally in all nerves. Better results have the radial nerve [6, 18]. The proximal end of the nerve has a reduced rate of regeneration compared to its distal segment. The time elapsed until the surgical intervention also influences the final result so that an early repair and a graft under 10 centimeters improves the prognosis [6].

Nerve reconstruction with autograft substitutes

Although autologous nerve grafts have many benefits, more and more researchers focus on the development of alternative grafts that behaves as accurately as a native nerve and overcomes the disadvantages of autograft. The ideal replacement graft should have the following attributes: widespread availability, an exact caliber as the recipient nerve, structural and mechanical properties similar to the genuine nerve, should contains fibroblasts and capillaries and a large number of Schwann cells for regeneration [20].

a) Nerve conduits

There are numerous types of nerve conduits like biological autogenous, biological nonautogenous and nonbiological tubes [2]. Modern conduits are made of polyesters or denatured collagen and aim to form a skeleton or a platform that allows the diffusion of oxygen and micronutrients from the outside to the fibrin matrix. Thus, it allows the local accumulation of neurotrophic factors [3, 20]. Various materials have been manufactured so far but their major disadvantage is the absence of laminin scaffold and the Schwann cells [3]. According to the available studies the outcomes are often reasonable.

Woven polyglycolic acid conduit gave superior results of sensory function compared to direct suturing or autograft when the nerve gap was below 4 mm. Another synthetic material made of denatured collagen obtained favorable evaluation in clinical trials when the difference between the nerve stumps was less than 15 mm. However, studies do not show a significant difference between direct suturing and the collagen graft. Moreover, synthetic materials can give severe complications such as nerve scarring and inadequate regeneration.

Polymer-based tubes have the benefit of being transparent and thus allow a more accurate suture. Although this material has the ability to resorb in a period of 3 to 24 months the results are not very satisfactory even when the lack of substance is less than 20 mm. An increased rate of complications has also been reported, including tube fistulisation, which is why some authors do not recommend this type of material [20].

Mokarram N. et al. demonstrates the efficiency of an immunoengineering technique in the nerve regeneration using an anti-inflammatory recruiting factor, fractalkine. This recruits a subtype of monocytes, which increases the permeability of the polysulfone conduit and stimulates axonal growth [21].

In conclusion, although the synthetic conduits are a more convenient alternative because of their biocompatibility and protective environment to the nerve ends, their benefits are not spectacular and occur only when the gap is less than 1 cm [20].

b) Nerve allografts

Allografts are used in case of large nerve gaps and require up to 2 years of immunosuppressive therapy, which is why their utility is limited [3]. The cadaveric harvested grafts have an adequate microarchitecture and adjuvant neurotrophic factors for superior axonal regeneration [20]. Irradiation, cold preservation or lyophilisation are some techniques used to preserve the graft and decrease the antigenicity or the immunogenic response of it. However, these methods decrease the number of Schwann cells and thus reduce the chance of a better regeneration [3]. The benefits of nerve reconstruction using a graft gathered from a donor or corpse is safe and effective on sensory nerves with a gap of up to 70 mm, method proved in several studies made on digital nerves. For peripheral nerves, proper functional benefits were also reported with 54% recovery in mixed nerves and up to 71% in motor nerves. Negative results were also observed, some authors informed about reconstructions that did not lead to a recovery of the initial nerve function. Compared to the conduit repair, the allograft has good statistical results, when the gap length stand between 15 mm and 65 mm. Processed nerve allografts are also convenient in other situations like reconstruction of a donor or biopsied nerve, management of neuromas and as extensive grafts in nerve transfer. We can say that allografts are a good alternative, which have promising results even when the length of the lesion exceeds 70mm, but also in simple and complex lesions of the peripheral nerves [20]. However, some studies do not recommend replacing autografts with decellularised allografts in proximal nerve damage or when it comes to a motor nerve reconstruction with a gap greater than 3 cm [2].

Nerve transfer

Nerve transfer technique involves the use of a healthy distal branch of a nerve that transfers to an injured nerve close to its neuromuscular junction [4]. This method has benefits especially when it comes to distal nerve trunk lesions, since the coaptation is near the targeted muscle and thus its re-innervation occurs faster [19]. In case of nerve transfer the results are not concordant for all type of nerve. They depend on the type of nerve, the intervention difficulty and surgeon's experience and also on the initial injury magnitude [22].

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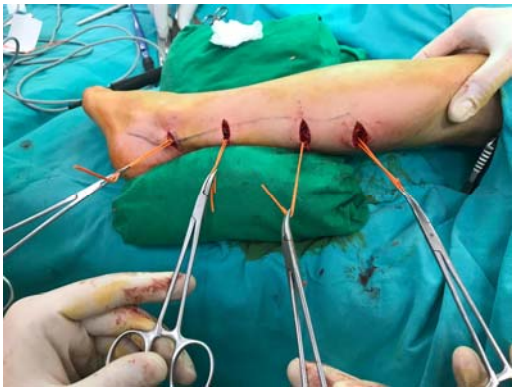

Fig. 4. Autograft harvesting

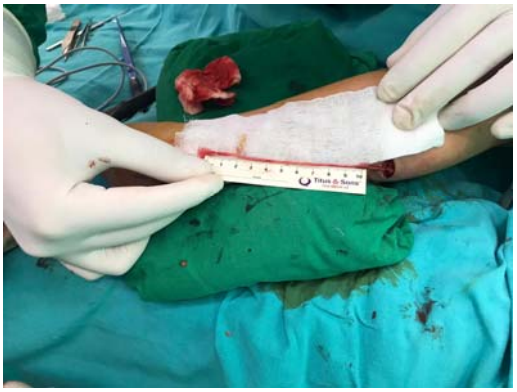

Fig. 5. Sural nerve graft

Some authors [23] recommend the correction of nerve injuries using both nerve graft and nerve transfer to minimize the post-lesion pain. The nerve transfer can be performed using the end-to-end or the reverse end-to-side procedure. The first one is used in high-grade proximal lesions with no expectation of recovery after primary nerve reconstruction, while the second one is used when the nerve can recover some of the initial function after the direct suture, usually in children [19]. The donor nerve must meet several criteria for good functional results. It must be as close as possible to the neuromuscular junction innervated by the injured branch, each fascicle sutured must have the same function sensory or motor, and the number and diameter of the fibers should be approximately between the recipient and donor nerves [19, 22]. Muscle tissue is capable of generating response to a received nerve stimulus as long as the percentage of connections between nerve fibers and the motor plate remains over 20%. This number can be increased by sewing more fibers from the donor nerve or by a double fascicular transfer. Below this percentage the ability to generate muscle tension drops dramatically [22].

Referring to the peripheral nerve traumas of the upper extremity, we will analyses 3 types of lesions as well as the most relevant techniques of reconstruction using nerve transfer.

Soldado F. et al. (2016) exemplify in his article the functional deficits after a proximal injury of the median nerve. Furthermore he explains the reconstruction methods and shows their results after the surgical intervention. The clinical deficits observed after the lesion are not always in agreement with the theoretical ones. According to the literature, all patients present grip and pinch deficiency and flexion impotence of thumb and forefinger. However, pronation is largely preserved at more than 50 degrees, flexion of the wrist and middle finger is complete, and the opposing function of the thumb is maintained at half of its potential. Sensitive deficits are also arguable, with some authors claiming that the patients present general palmar anesthesia, while others claim in their findings that the anesthesia occurs just at the distal phalanx of the first three digits.

The nerve transfer is preferably done in the first 6 months after the injury. If the maximum limit of 12 months is exceeded, another intervention such as tendon transfer can be used.

The author's preferred techniques [23] are the transfer of the nerve corresponding to the extensor carpi radialis brevis to the anterior interosseous nerve, for improvement of fingers flexion; the nerve of the supinator towards the flexor digitorum superficialis, for grasping reestablishment; and the nerve of the abductor digiti minimi to the thenar muscular branch for pinch and thumb opposition restoration. The sensory function is recovered by transferring the ulnar or radial dorsal digital nerve branch to the adjacent median palmar nerve [23].

Pet M. et al. (2016) makes a brief presentation of the radial nerve injuries and their following consequences. The most frequent lesions appear after humeral fractures in 11.8% of the cases. The clinical manifestations are presented as the inability of wrist and fingers to extend [18].

The surgical treatment consists of transferring the nerve of the flexor digitorum superficialis muscle (FDS) to the extensor carpi radialis brevis (ECRB), a method described in many studies, which improves the hand extension. To aid and relieve the finger extension, a second nerve transfer is needed, which is made from the flexor carpis radialis to the posterior interosseous nerve.[18, 24] Donor muscle deficiency is negligible in both situations, the muscle functions being easily taken over by other muscles. The pronator teres (PT) tendon transfer to the extensor carpi radialis brevis (ECRB) stand as an adjuvant step for a faster extension function recovery and can be added to the nerve transfers (high radial nerve injury - nerve transfers for the restoration of wrist) The three maneuvers are performed in the same operative time and show good results with a proper recovery after the trauma [18].

Other authors support only the transfer of the flexor carpis radialis (FCR) corresponding branch to the posterior interosseous nerve (PIN) along with the end-to-side transfer of the pronator teres (PT) tendon to the extensor carpi radialis longus (ECRL), yet with unsatisfying effect on the extension of the hand [25].

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Sensitive branches of the radial nerve are very rarely damaged. When it occurs the sensory deficit is represented by numbness in the distal portion of the dorsal face of the forearm and hand. Surgical treatment is performed by end-to-end anastomosis of the lateral antebrachial cutaneous nerve to the radial sensory nerve or end-to-side anastomosis of the radial sensory nerve to the median nerve [18].

Ulnar nerve injuries are the most common nerve lesions. Unfortunately, these injuries have poor results after conventional surgery, which is why some authors question the usefulness of the intervention [19, 26]. The lesion is clinically noticeable by the occurrence of clawed hand, the patient's inability to flex the metacarpophalangeal joints and to extend the distal interphalangeal joints. This disabilities combined with the 5th finger opposition impotence affects further the grab and pinch function. The sensory deficit appears on the palmar face of the 4th and 5th fingers and may not emerge if the insult only affects the deep ulnar branch [27].

The surgical option for restoring the motor function of the ulnar nerve is represented by the transfer of the anterior interosseous nerve (AIN) to the motor branch of the ulnar nerve, a medial split of the ulnar nerve following the Gyon canal in the proximity of the hamate bone. The anterior interosseous nerve contains approximately 506 nerve fibers at the distal forearm level, while the motor nerve branch of the ulnar nerve contains over 1500, therefore the transfer will lead to weak recovery, but sufficient to prevent the "clawed hand" [26]. The surgical technique consists of a tension free anastomosis using 9-0 suture under the operating microscope. In the case of concomitant lesions of the ulnar and medial nerve, the posterior interosseous nerve is mobilized through the interosseous membrane aperture to the motor branch of the ulnar nerve. To regain the ulnar sensory function, the nerve transfer is practiced between the median nerve ramification of the third web space and the sensory branch of the ulnar nerve [19].

The results after nerve transfer are promising, with many authors reporting that the grab and pinch strength of the operated patients increased substantially. It is concluded that nerve transfer is an adjunctive method for peripheral nerve injuries that encounter poor or insufficient results after nerve graft or direct suture [19].

Summary

Nervous injuries are a serious health problem due to their complexity and the effect they have on the individual's life. Both motor and sensory transmission are affected, which have a long-term resonance, their treatment being complex and entail more than one medical branch. Most of the time, in order to see the desired result, the patient has to be compliant to the different medical recovery techniques. Even so, in some cases the long-term sequelae prevent the patient from carrying out his daily activities. The neurorrhaphy techniques have evolved because of the increasing use of the available technology, operative microscope, and appropriate surgical instruments and suture threads.

In conclusion, we can say that the direct suture of the nerve is ideal as long as it is done in a timely manner. The nerve graft has its role especially when the distance between the nerve stumps is large and classical anastomosis cannot provide a tensionless suture. Thereby, the nerve graft can cover large gaps with satisfactory results. Nerve transfer can be considered as an adjuvant method of direct suture or nerve graft, when there are not adequate outcomes. This method offers the possibility of reconstruction close to the motor plate, which is motivating due to the early recovery and the suitable long-term results.

Nerve repair or neuropathies are complex surgical manoeuvres with variable results that can be pushed to perfection when the principles of the technique are respected.

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PEDIATRIC TIBIAL SPINE FRACTURES – TREATMENT OPTIONS

Narcis Flavius Tepeneu[1]

Abstract

Pediatric fractures of the tibial spine are relatively rare and controversy remains around how these injuries are best managed. Consequently most non-specialized paediatric units have limited experience of managing these injuries. Injuries that rupture the ACL of an adult typically avulse the anterior tibial spine in a growing child. The conservative treatment of un-displaced fractures (type I) is unambiguous and simple. However, difficulties may arise in relation to the treatment of type II and III fractures, since an anatomical reduction of the fracture and reconstruction of the articular surface are required to preserve the function and the stability of the knee joint. Several methods have been described for the treatment of avulsion of tibial eminence, including operations performed by using either arthrotomy or arthroscopy. The fixation of the fragments can be performed by utilizing Kirschner wires, cerclage wires, intraosseal sutures, epiphyseal cannulated screws, screws led through the fragment and screws and bone anchors inserted retrogradely.

Keywords: Fracture, tibial spine, Meyers and McKeever classification, children

Introduction

Fractures of the tibial spine exhibit a bimodal age distribution, occurring in both the pediatric and adolescent populations. They commonly occur between the ages of 8 to 14. Fracture of the tibial spine is relatively rare. The incidence is 3 per 100,000 pediatric trauma cases per year, accounting for only 5% of pediatric knee effusions [1]. Consequently most non-specialized pediatric units have limited experience of managing the injury.

The most common causes of these fractures are bicycle accidents and athletic activities.

The mechanism of injury is a combination of hyperextension and internal rotation at the knee, causing the anterior cruciate ligament (ACL) to become taut. This motion represents the same mechanism often attributed to ACL rupture. The difference between the two injuries is a reflection of the properties of pediatric bone, which is more vulnerable to injury than the ligament as opposed to the skeletally mature adult where the opposite is true.

Pediatric tibial spine fractures typically occur in isolation, but the equivalent adult injury commonly occurs in association with injury to other structures notably the menisci and collateral ligaments. Although the ACL rarely ruptures in children is commonly stretched during the injury leaving a degree of laxity, which may lead to subtle knee instability.

A child presenting with an acute swollen knee after falling from a bicycle should be presumed to have a fracture of the tibial spine until proven otherwise. Some children are unaware that anything is seriously wrong until the following day, when the painful hemarthrosis persists.

They are usually unable to bear weight on their affected extremity. On physical examination, there is often a large hemarthrosis because of the intra-articular fracture and limited motion due to pain, swelling, and occasionally mechanical impingement of the fragment in the intercondylar notch. Sagittal plane laxity is often present, but the contralateral knee should be assessed for physiologic laxity. Gentle stress testing should be performed to detect any tear of the medial collateral ligament (MCL) or lateral collateral ligament (LCL) or physeal fracture of the distal femur or proximal tibia.

The radiologic findings can be subtle, and the damage is always greater than the x-ray shows. Wide radiolucent wings of articular cartilage from the weight-bearing surface of the tibia are attached to the small osseous fragment. Much more than the spine is lifted up and the fragment is usually partially detached. When the fragment is completely detached, meniscus are interposed or the fragment is rotated, and open reduction is required.

Material and method

A retrospective study in the period 01.06.2017-01.06.2020 was conducted on cases that were managed by the author of the article. A total of 5 cases were identified. A review of literature was also conducted.

Results

There were 3 male and 2 female patients, mean age of 10,2 years. 2 patients suffered a bicycle fall, 2 patients had skiing accidents, and one patient suffered a fall after a slip on wet grass during a football match. 3 patients had Type I one fractures and were successfully managed by conservative treatment in a cast. 1 patient had a Type II fracture and closed reduction and casting of the knee in hyperextension was successful at reducing the fracture. The patient was also managed by conservative treatment in a cast, the follow-up radiographs did not show any secondary displacement.

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The last patient had a Type III fracture and was managed by knee arthrotomy via an open medial para-patellar approach, open reduction and osteosynthesis with 2 cannulated epiphyseal screws and washers.

All cases had a favorable outcome with a full recovery of knee range of motion (ROM), good Tegner Lysholm score and good stability of the knee joint.

Table 1. Summary of patients

Patient	Gender	Age (years)	Myers and McKeever grade	Treatment	Tegner Lysholm score	Complications
1	M	11	I	Cast	100	None
2	F	10	I	Cast	98	None
3	M	9	I	Cast	100	None
4	F	12	II	Closed reduction +cast	96	None
5	M	9	III	Open reduction + 2 cannulated screws + 2 washers	96	None

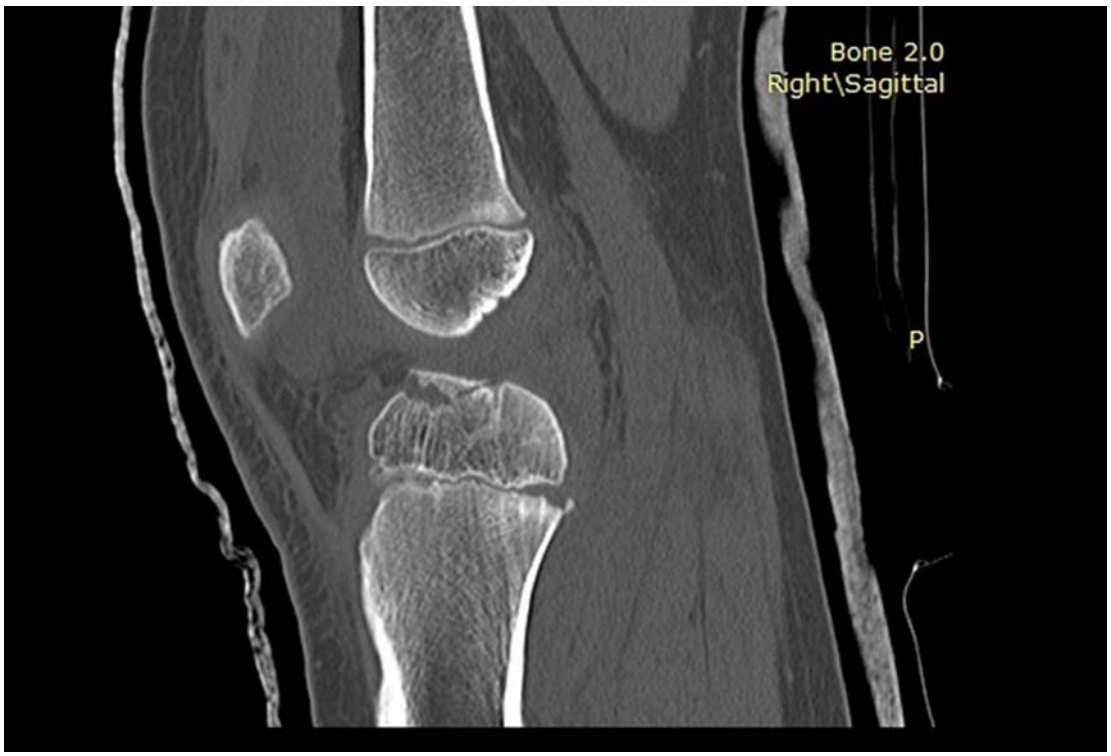

Fig. 1. Preoperative sagittal CT image of the right knee showing a Meyers and McKeever type III displaced tibial spine fracture

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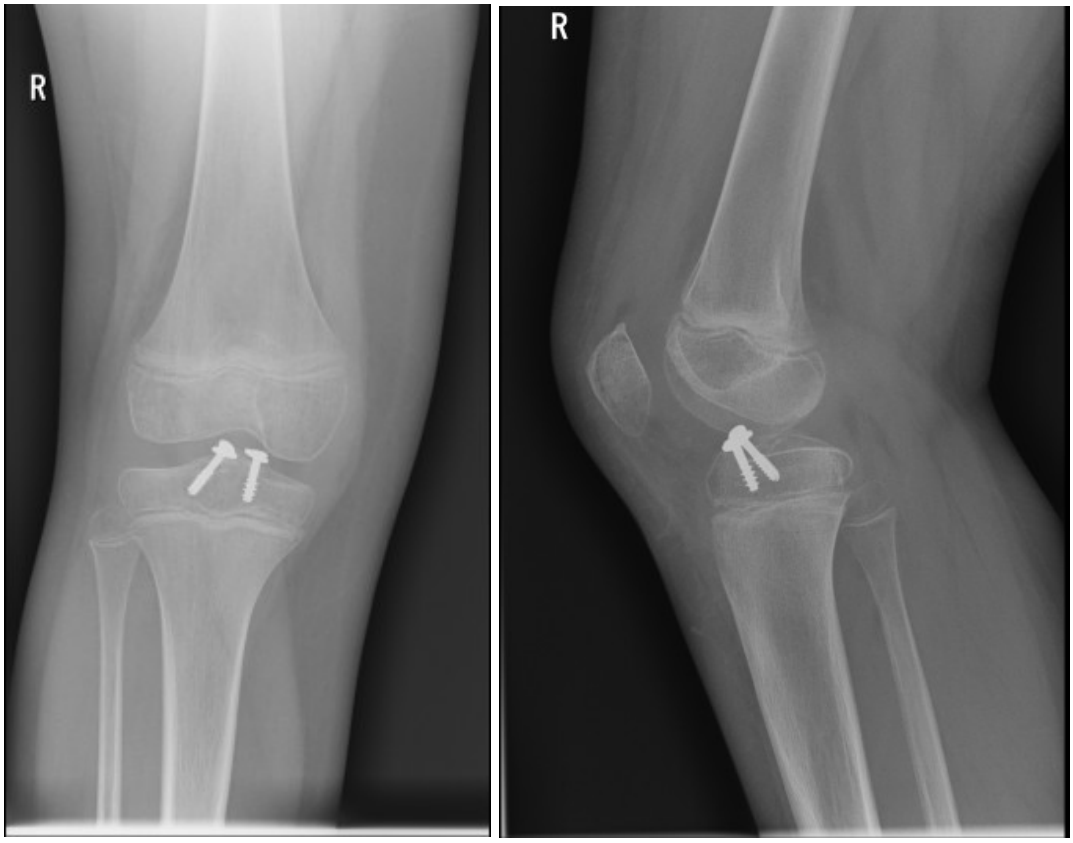

Fig. 2. Postoperative X-Ray images (4 month after surgery) showing a healed fracture with 2 cannulated epiphyseal screws and washers)

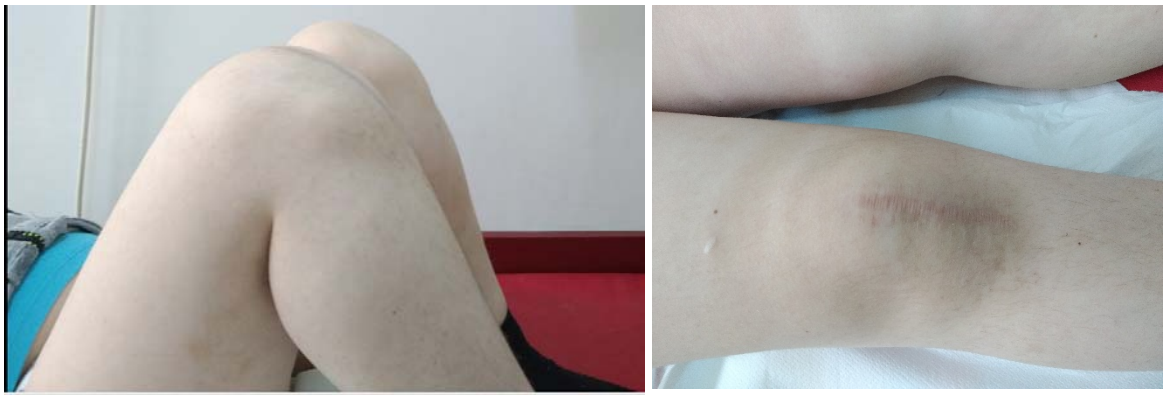

Fig. 3. Postoperative clinical images, showing symmetrical ROM of both knees

Discussions

The most serious limitation of our study is the small number of cases, due to the rarity of the pathology and the limited time interval. In most of our cases tibial spine fractures were sustained as a result of sporting injuries. This has been consistently reported in the literature and has been associated with activities ranging from cycling to skiing, which are representative of pivoting movements that would render the ACL taut [2,3]. Our results on the small number of cases indicate that both male and females are of equal risk of such an injury. To our knowledge, the available literature does not comment on the distribution of such fractures between the different genders. Conservative management, consisting of knee immobilization, is generally accepted as the treatment for Type I injuries [4,5,6], although controversy remains regarding the preferred position of immobilization, from slight flexion to relax the ACL or full extension to allow the femoral

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condyles to reduce the tibial spine fragment. There are a wide range of management practices for type II and type III injuries reported in the literature [5]. Over the last 10-15 years there has been a gradual shift towards open reduction and internal fixation (ORIF) and more recently arthroscopic reduction and internal fixation (ARIF). [4,7] Within the ORIF and ARIF groups many techniques have been described including the use of screws, K-wires, suture anchors and more recently meniscal arrows. [7, 8, 9] Two systematic reviews evaluating the effectiveness of different methods of fixation did not show any conclusive evidence that any method was superior to the others [4, 7]. Wilfinger et al. performed a retrospective clinical analysis on 38 pediatric reducible tibial spine fractures, which had all been treated in cast immobilization, regardless of the type of injury [3]. The authors reported that the overall functional outcome was good, with pain being reported as 'seldom' and mostly in patients that had type II and type III injuries. Although no objective knee scoring system was used and patient outcomes were recorded qualitatively, the outcomes in their type I and type II injuries were comparable to the patient outcomes in this study. This would suggest that rather than treating all type II injuries with surgery it would be of benefit to differentiate those type II injuries that are reducible, from those that are not, in order to establish which patients benefit from surgery. Edmonds et al. performed a retrospective study that documented the outcomes of paediatric patients that had either closed reduction or surgical fixation of their tibial spine fractures [5] The authors concluded that those type II injuries that had less than 5 mm elevation demonstrable on plain radiographs can be considered as minimally displaced and had good functional outcomes following closed reduction and casting.

Soft tissue interposition is a recognized phenomenon that can complicate closed reduction. In one study of 80 patients that required surgical intervention, it was demonstrated that 36 of the cases were not reducible due to interposition of the medial meniscus within the fracture site. Also implicated in the study was the anterior horn of the menisci and the transverse ligament.

This may account for the inability of a fragment to be reduced in extension and has been reported in the literature to account for 32% of non-reducible cases [5, 10]. There is also a possibility for entrapment of the medial collateral ligament [11]. Currently no consensus has been reached with regard to the best surgical option. Broad options include open reduction and internal fixation or arthroscopic reduction and internal fixation [7].

Very little is documented about the incidence of symptomatic ACL laxity within the literature, however the incidence of asymptomatic ACL laxity is well known, albeit quite variable. [5, 12, 13, 14]. This highlights the importance of three dimensional imaging, especially in type II and type III fractures. Previous authors have advocated its use in delineating the degree of displacement and involvement of the tibial plateau and some suggest that MRI should be used over CT to reduce radiation risk [14, 15, and 16]. In one study examining the use of 3D imaging and its effect on treatment planning and fracture classification, it was found that as the patient's investigations moved from radiographs to CT to MRI the fracture classification was changed in 6% and 21% of cases respectively. It was reported that MRI evaluation changed the treatment plan in 23% of cases [16].

This not only highlights the importance of the clinical examination of the patient and of the high grade of suspicion for such an easy to miss fracture, but also the importance of three dimensional imaging [16, 17]

Stiffness (limitation of full flexion and/or extension) following surgical treatment could persist for up to 6 months, but would often improve with physiotherapy. If it did not then metalwork removal is beneficial. Follow- up of the patients in the current study have yielded good outcomes and Lysholm scores comparable to scores reported in the literature.

The prognosis for closed treatment of nondisplaced and reduced tibial spine fractures and for operative treatment of displaced fractures is good. Most series report healing with an excellent functional outcome despite some residual knee laxity. Potential complications include nonunion, malunion, arthrofibrosis, residual knee laxity, and growth disturbance [18, 19, 20, 21, 22, 23, and 24].

In summary, isolated paediatric tibial spine fractures can be successfully managed non-operatively in an extension cast and this should be the normal management of the type I injury. Displaced tibial spine fractures can also be initially managed in this way. Should a displaced fracture not reduce in extension cast then soft-tissue interposition should be suspected. Three dimensional imaging, such as a CT scan, should be used to assess the fracture displacement and anatomy to help guide management. An open knee arthrotomy or arthroscopy should be used to reduce and fix the fracture. This protocol has the potential to reduce the need for unnecessary imaging and surgery.

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MENTZER INDEX IN PEDIATRIC THALASSEMIA TRAIT

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Abstract

Thalassemia is a group of inherited diseases of the blood that affect a person's ability to produce hemoglobin, resulting in anemia. The incidence of thalassaemia carriers is high in regions such as Mediterranean, Middle East, Indian subcontinent, Southeast Asia and South China. In the past few decades, migrants from the thalassaemia prevalent countries to non-prevalent countries, mainly North America and Central and North Europe, are rapidly increasing in number. The objective of this study is identifying the pediatric patients with beta thalassemia minor or thalassemia trait and the importance of differential diagnosis of minor thalassemia to a hypochromic anemia of another cause using Mentzer index. The study included 40 patients diagnosed with beta thalassemia minor and treated at the Pediatrics I Clinic of Târgu Mureş Hematology-Oncology Department during 2007-2017 and it demonstrates the efficacy of using the Mentzer index (MI) in medical practice.

Keywords: thalassemia, child, hemoglobin electrophoresis, Mentzer index

Introduction

Beta-thalassemia is a hereditary condition caused by low hemoglobin synthesis resulting in variable phenotypes ranging from severe anemia to clinically asymptomatic individuals. World Health Organization (WHO) has recognized thalassemia as the most common hematological genetic disorder in the world found in more than 60 countries and is very common among children in the Middle East, the Mediterranean and South Asia. In Romania the frequency of thalassemia is estimated at 5% (1,2).

Thalassemia minor also called thalassemia trait can be clinically asymptomatic because only one beta-thalassemic gene is affected. Heterozygotes are carriers of this gene and may have moderate anemia. When both parents are carriers there is a 25% risk at each pregnancy of having children with homozygous thalassemia (3). Thus it is very important to identify cases of beta thalassemia minor because the mutation can be transmitted further or in the case of carriers there is the possibility that mothers give birth to homozygous children.

Thalassemia minor is characterized by reduced mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH), normal or low hemoglobin (Hb), with increased Hb A2 level, normal/ increased iron level, increased ferritin level, moderately high indirect bilirubin. The peripheral blood smear shows microcytosis, hypochromia, anisocytosis, poikilocytosis. Carriers have less severe red blood count morphologic changes than affected individuals (4). Beta thalassemia minor is confirmed by Hb electrophoresis that highlights HbA2 > 3.5%, low HbA 90-95%, and Hb F of 50%. Typical beta-thalassemia carriers are identified by analysis of red blood cell (RBC) indices, which shows microcytosis (low MCV) and reduced content of Hb per red cell (low MCH). MI index is used by clinicians as differential diagnosis between beta thalassemia minor and iron deficiency anemia; it is calculated dividing the MCV value to RBC value; thus MI >13 is raising a high suspicion of iron deficiency anemia and MI <13 is raising a suspicion of thalassemia. When the hematologic analysis is abnormal, molecular genetic testing of beta globin gene is performed to identify the disease-causing mutation (5). Fortunately, most cases of minor thalassemia do not require treatment. Supplementary folic acid can be prescribed to patients with thalassemia trait to prevent deficiency from hyperactive bone marrow. It is recommended to avoid iron supplements and foods that increase the amount of iron in the organism (6). Genetic counseling and genetic testing are recommended for families who carry a thalassemia trait (7).

People with β-thalassemia trait should be warned that their condition can be misdiagnosed as the more common iron deficiency anemia.Thus our aim was to identify the pediatric patients with beta thalassemia minor using MI and differentiate it from a hypochromic anemia of another cause.

Material and method

We conducted a retrospective and descriptive study that included 40 pts under the age of 18, diagnosed and treated at the Pediatrics I Clinic in Targu Mures, the Hematology-Oncology Department, during 2007-2017. The inclusion criteria was Hb A2 > 3.5%. Also the following were observed: the number of erythrocytes, hemoglobin concentration, hematocrit, MCV, reticulocytes and erythrocyte morphology, serum iron, level of Hb A2, MI value. Also, gender, age at diagnosis, family and personal history of anemia, clinical signs of onset: abdominal pain, headache, jaundice.

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Table 1. Average, minimum and maximum values of laboratory analysis

Other Laboratory Analysis	Maximum value	Mean value	Minimum value
RDW (%)	33.1	18.22	13
Reticulocytes (%)	92	28.52	8
Serum Iron (qmol/L)	34.59	15.31	2.31

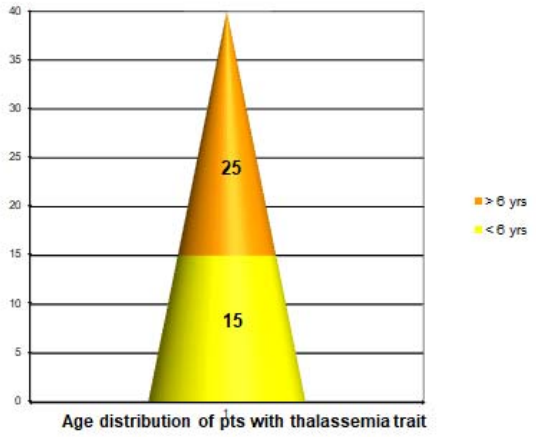
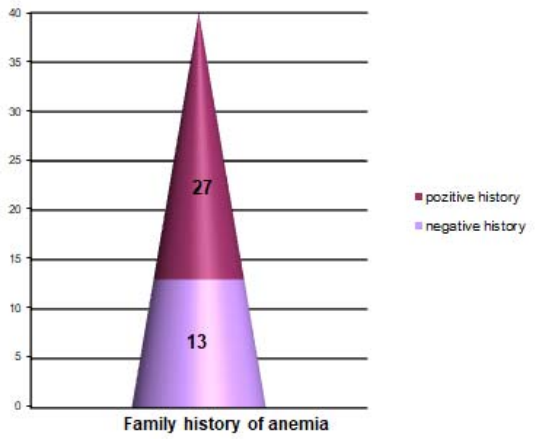


Fig. 1. Age distribution



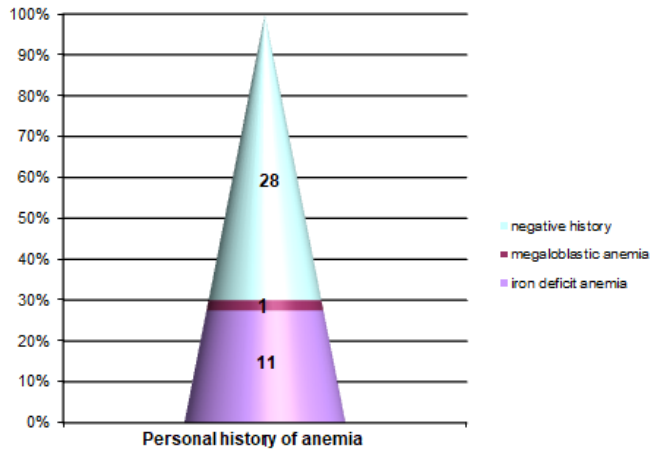


Fig. 2 a and b. History of anemia

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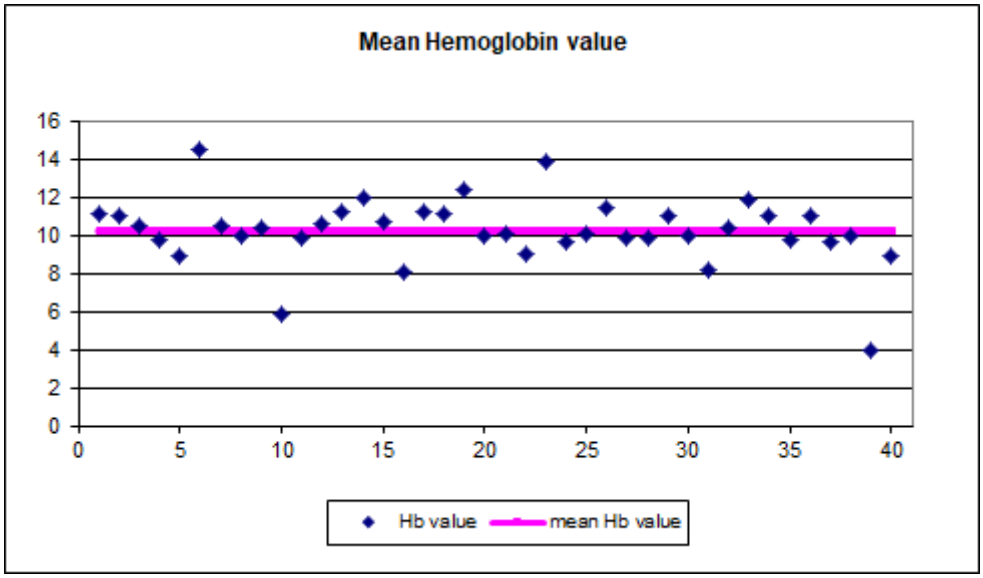

Fig. 3. Hemoglobin value

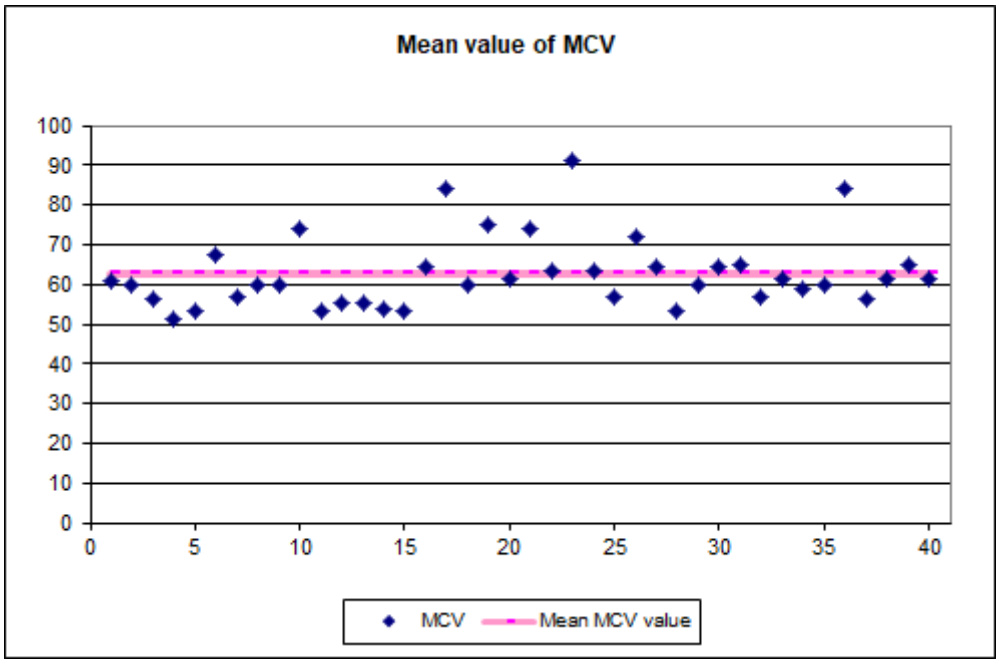

Fig. 4. MCV value

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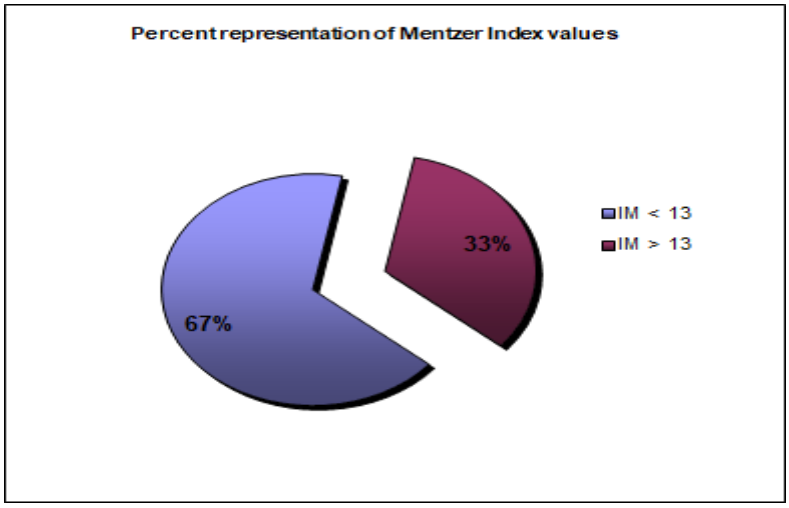

Fig. 5. Metzer index

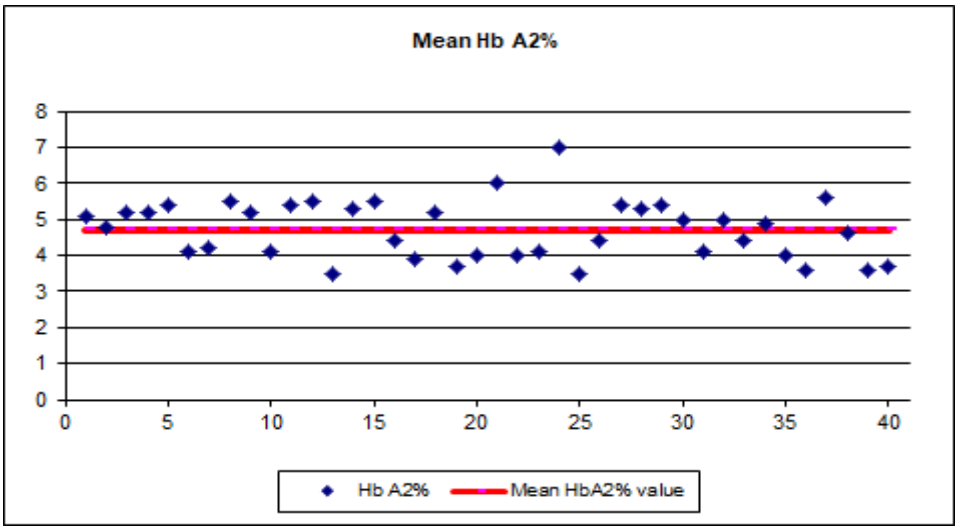

Fig. 6. Hb A2%

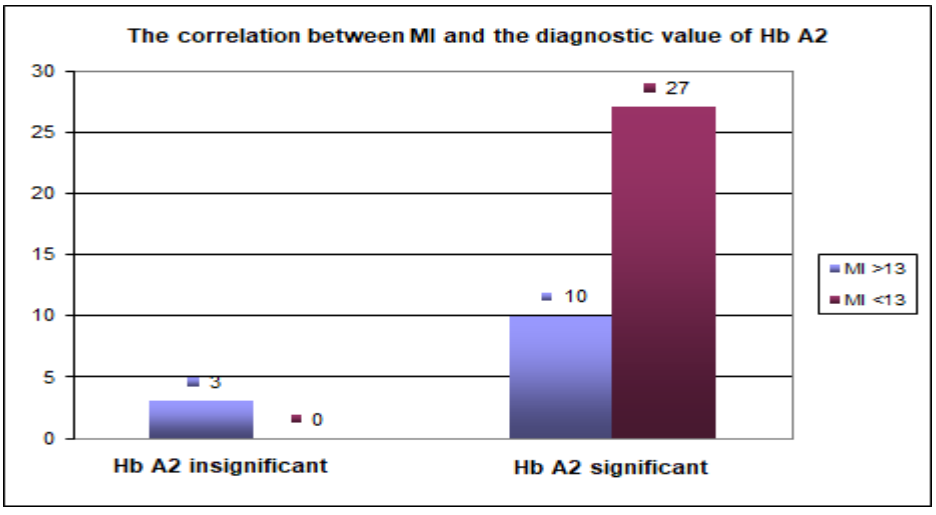

Fig. 7. Correlation MI and Hb A2

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Results and discussions

Through this study we have attempted to demonstrate that by carefully analyzing hematological parameters of the CBC and calculating a single index, we can orientate ourselves to a correct diagnosis and avoid the inappropriate treatment of a patient with an alleged iron deficit anemia.

The distribution of patients (pts) according to gender revealed 24 girls and 16 boys. Although literature describes an equal gender distribution, we noticed a slight predominance in females (60%) versus males (40%) (7). Beta thalassemia minor is poor in clinical signs and symptoms, which is why the diagnosis is often late, as it was found in this study; the mean age of pts enrolled at the time of diagnosis was 8.3 years, with a maximum of 18 years and a minimum of 6 months. We noticed that the number of cases diagnosed is more numerous at the age above 6 years (Figure 1).

Anamnesis and clinical examination are indispensable to establish a correct diagnosis. Patients need a thorough and complete assessment. In this study family history has a great importance because it can guide the doctor to a possible congenital anemia diagnosis. 27 pts had a positive family history for anemia of different types, from which 5 had first degree relatives diagnosed with minor thalassemia. 12 pts had a personal history of anemia, one had megaloblastic anemia (Figure 2a, b).

At the time of diagnosis, 36 pts showed clinical signs of onset, of which 22 pts had pale mucosa/skin, 9 pts abdominal pain, 3 pts headache and 2 pts had jaundice. A retrospective study in Korea between 2000 and 2011, where the incidence of thalassemia is very low, showed that the vast majority of children (78%) tested for beta thalassemia were asymptomatic, they were accidentally diagnosed due to the fact that the complete blood count (CBC) was performed for another reason (8).

As for laboratory analysis, we observed that in 63% of patients the CBC showed a normal number of RBC and in only 5% cases the RBC was low. The mean of RBC values was 5.11 million /mm3, with a minimum value of 2.13 million /mm3 and a maximum of 6.48 million /mm3.

Hb was low in 38 pts; the mean Hb was 10.24 g/dL (Figure 3). In a 2009 American article Claude O.B explains the easiest way to separate thalassemia trait and iron deficiency anemia is by simple inspection, bacause thalassemia trait rarely causes anemia of less than 10 g/dL of hemoglobin (9).

The lowest value Hb 4g/dL, was clinically manifested by severe anemia requiring RBC transfusion, in a patient associating megaloblastic anemia, this masked the diagnosis of beta thalassemia, at the time of diagnosis MCV was increased, after correction of vitamin B12 deficiency, microcytic anemia persisted with a hemoglobin value of 4g/dL and a erythrocyte count of 2.13 mil, calculating MI that was under 13, hemoglobin electrophoresis was performed for suspicion of minor beta thalassemia and, as a result, this hypothesis was confirmed.

97% of pts had a low hematocrit value and only 3% had a normal value. MCV is a very important parameter in the diagnosis of microcytic anemia, in 95% patients MCV was below 80fl. As one of the most indicative parameters, we calculated its average value: 62.6 fl with a maximum value of 90.6 fl and a minimum value of 50.8 fl (Figure 4). All 38 low MCV patients had characteristic erythrocyte morphology for thalassemia. A study from Pakistan suggests that careful monitoring of CBC parameters, including RBC indices and morphology, along with clinical findings are essential to diagnose carrier cases, especially in high prevalence areas (10).

All patients had a high number of reticulocytes, interpreted as an indicator of effective regenerative erythropoiesis; reticulocytosis is characteristic in beta thalassemia. From the group studied, we noticed that 26 of pts had normal iron levels, 9 pts had decreased iron levels, and 5 pts had increased iron levels. Iron overload is a major problem of beta thalassemia and it occurs more commonly in beta thalassemia major than in thalassemia trait, as described in a Romanian study. Also iron overload is considered a complication that appears in adult life, as in the study Tudor Arbanas et al describes in the Romanian study that all thalassemics without complications were younger than 25 years old, half of them being under 14 years old (11). Other laboratory tests are shown in table 1. Related to MI 67% of patients had an index under 13 (Figure 5). The results of our study on the utility of MI in diagnosing of thalassemia are consistent with other studies. With regard to the Mentzer index, several similar studies have concluded that this index is best suited to direct the diagnosis to a beta thalassemia. A retrospective study evaluated the safety of calculating various indicators for the diagnosis of microcytic anemia and beta thalassemia. This study was conducted on a group of 290 carefully selected children, calculating 12 indices that could suggest the diagnosis of thalassemia or iron deficiency anemia. Their conclusion was that MI is the safest among the 12 indices, with the highest sensitivity (98.7%) and specificity (82.3%), and also the easiest to use and accurate to detect a possible beta thalassemia, according to their results the percentage of correctly diagnosed patients was highest with the Mentzer index (91%) (12).

Hb electrophoresis is the most important investigation to confirm the diagnosis; in the studied group all patients benefited from this analysis and the results of the Hb electrophoresis are presented in Figure 6. The mean Hb A2 is 4.72%, with a minimum value of 3.6% and a maximum of 7%. All patients who had HbA2 value of > 3.5% had a MCV <80fl, high red cell distribution width (RDW) and a characteristic thalassemia smear. Statistically analyzing the correlation between Hb A2 and the Mentzer index we obtained the following results: elevated levels of Hb A2 confirming beta thalassemia minor, were correlated statistically significant with MI <13 suggesting thalassemia ($p = 0.0289$), (Figure 7). Also a statistically significant correlation with a $p = 0.0001$, was between the MI <13 and the peripheral blood smear characteristics for the same pathology. Many studies attest the relevance of new indices such as Youden's Index in the diagnosis of thalassemia beta minor, also a Pakistan study found a new reliable parameter

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to differentiate between iron deficiency anemia and thalassemia trait (13,14). Further studies must be made to establish whether one or more of these indices should be used in medical practice.

Conclusions

Beta thalassemia minor can be easily suspected based on routine hematological analysis when investigating other pathologies. This condition is often confused with iron deficit anemia because it has many clinical and paraclinical similarities or is underdiagnosed. Therefore iron supplements are often prescribed. Iron supplements may result in excess iron, which can collect in many areas of the body causing organ damage. Carriers should only take iron supplements if serum iron shows they are iron deficient. Most patients diagnosed our study are above 6 years old, this is probably due to poor clinical signs and symptoms of thalassemia trait. The most common indicators for thalassemia are: low MCV, low Hb, elevated iron levels, blood smear with microcytosis, and none the less MI <13. This study demonstrates the effectiveness of using the Mentzer index in medical practice in patients with any type of anemia especially in case of beta thalassemia minor suspicion, but confirmation of diagnosis is possible by conducting hemoglobin electrophoresis, which is the gold standard for the diagnosis of beta thalassemia minor

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TYPE III CONGENITAL PARAESOPHAGEAL HIATAL HERNIA – A RARITY IN PEDIATRIC SURGERY. A CLINICAL CASE AND LITERATURE REVIEW

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Abstract
A case of type III giant paraesophageal hernia in a child of 1 year and 6 months is presented. The child was operated through superior median laparotomy and the total reduction of the stomach in the abdominal cavity, the mobilization of the hiatal defect and hernia sac with its removal were performed. The posterior crurorraphy was done with strengthening of the zone by application of the equine pericardial acellular graft fixed by interrupted sutures. The anchoring of the stomach fornix to the left hemidiaphragmatic dome (gastropexy) and 180º partial anterior fundoplication were performed. The postoperative evolution was without complications and the patient was discharged in satisfactory condition on the 7 th day postoperatively. Conclusion: Using of canine pericardial acellular grafts could be a suitable option for the hiatal defect repairing in paraesophageal hiatal hernias in children, but this technique needs an adequate follow-up regimen.
Keywords: Hiatal hernia, equine pericardial acellular grafts

Introduction

Hiatal hernia (HH) is a variant of diaphragmatic hernia, characterized by transdiaphragmatic protrusion of the abdominal organs into the posterior mediastinum through the esophageal hiatus of the diaphragm [1, 2]. Pediatric HH occurs as a result of existence of the congenital diaphragmatic defect and many cases are asymptomatic [3].

Depending on the location of the gastroesophageal junction regarding diaphragm there are 4 types of HH [4, 5, 6]. Type I (85-95%) is an axial (sliding) hernia characterized by migration of the gastric cardia into the chest cavity, lack of the Hiss angle between the stomach and the esophagus and the development of the gastroesophageal reflux disease [7, 8]. Sliding HH is a result of widening of the muscular hiatal channel and the circumferential laxity of the phrenoesophageal membrane [9].

Types II, III and IV are paraesophageal hernias, constituting 5-15% from the totality of HH, which clinical significance is determined by the potential of mechanical complications [10, 11], although they are associated with gastroesophageal reflux too [12].Type II is a paraesophageal hernia (rolling HH) characterized by normal position of gastroesophageal junction which is fixed to the preaortic fascia and median prearcuate ligament, and the hernia sac contains the gastric fornix [4, 9, 13]. Type III (mixed HH) is a combination of type I and II hernias in which more than 50% of stomach is located in the mediastinum. In type IV the stomach is protruding in the mediastinum together with other abdominal organs. Along with the intrathoracic herniation of the stomach and gastroesophageal junction [14], the protrusion of duodenum, colon, omentum, spleen and pancreas could occur [15, 16, 17, 18, 19].

Paraesophageal hernia is a frequent diagnosis in adults [20], however in children it could be a complication after gastroesophageal or antireflux surgery or could be of congenital origin. [21, 22].

Congenital paraesophageal hernia is a rare nosological entity in children with obscure etiology and constitutes 3,5-5% from the all HH [6, 23, 24, 25]. The majority of cases occur sporadically, although familial cases of paraesophageal hernia are described [26, 27]. The term "giant paraesophageal hernia" is used in cases when more than 30% of stomach migrates into the chest cavity [28, 29].

We present a case of type III paraesophageal hernia in a child of 1 year and 2 months which was incidentally discovered.

Case report

The child I.M. 1 year and 6 months old was referred to the outpatient clinic of PMSI Mother and Child Institute with a suspicion of pulmonary tumor and pneumonia. At the admission the child complained loss of appetite, frequent regurgitations, periodic postprandial agitation. The onset of that signs was 3-4 months earlier. The plain chest X-ray in the outpatient clinic revealed a right sided cavitated mass (Fig. 1A). On upper gastrointestinal series the location of the gastroesophageal junction and a portion of stomach in the thoracic cavity was established ("sandglass sign") (Fig.1B) and the child was admitted in the "Natalia Gheorghiu" National Scientific and Practical Center of Pediatric Surgery.

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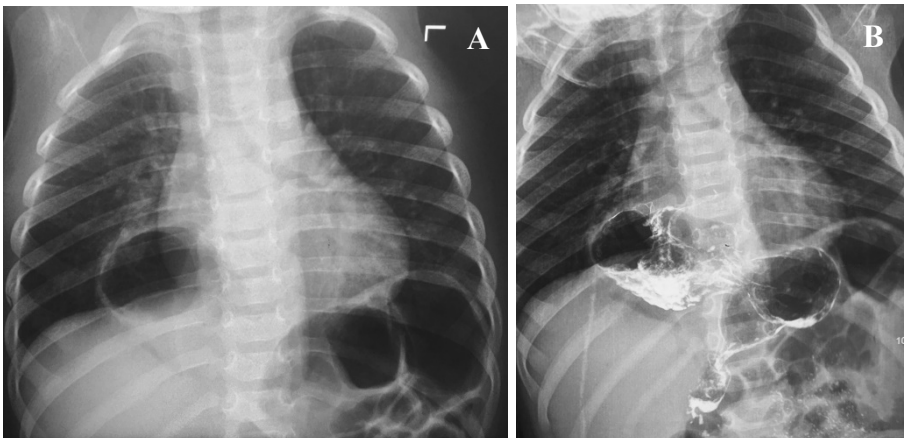

Fig. 1. Simple chest X-ray (A) – right sided intrathoracic cavitary mass.
Chest X-ray with upper gastrointestinal contrasting (B) – "*sandglass*" appearance of the stomach

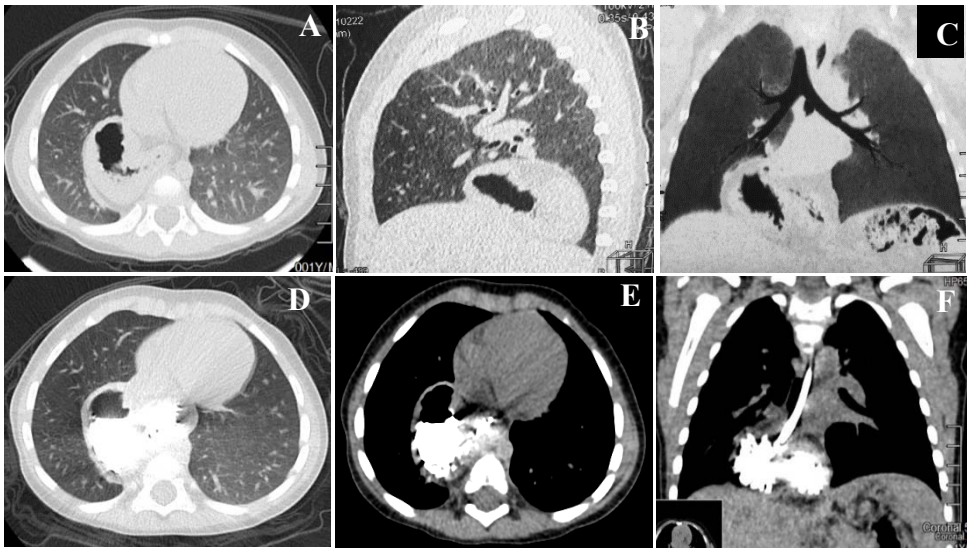

Fig. 2. Patient I.M. Computed tomography (the explanation is in the text).

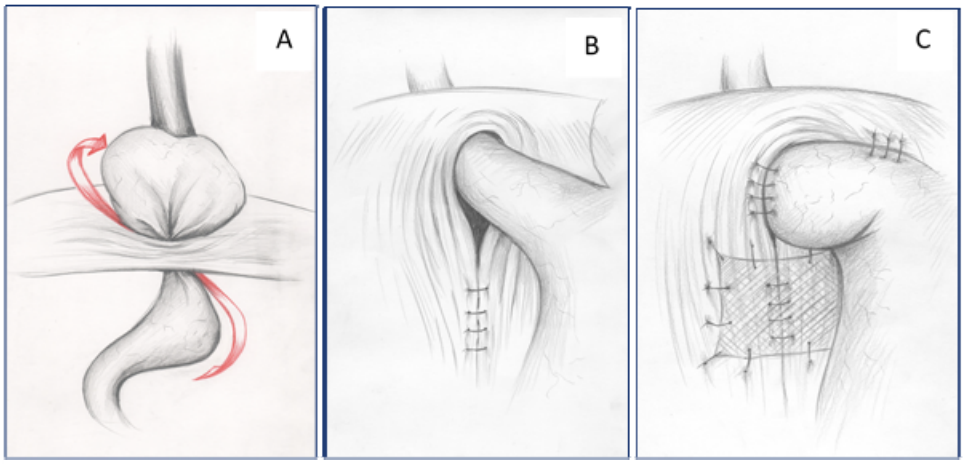

Fig. 3. Schematic presentation of paraesophageal hernia detected in patient I.M with partially intrathoracic located twisted stomach (A); B - the scheme of the curoraphy, C

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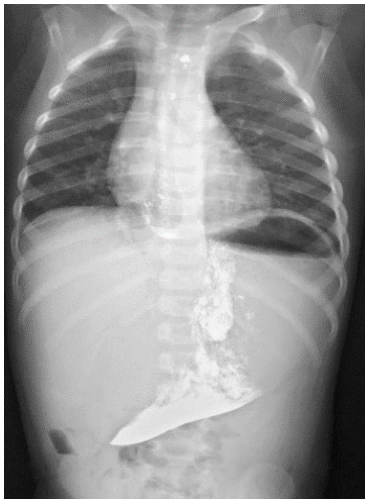

Fig. 4. Patient I.M. Chest and abdominal X-ray on the 7th day postoperatively (the explanation is in the text).

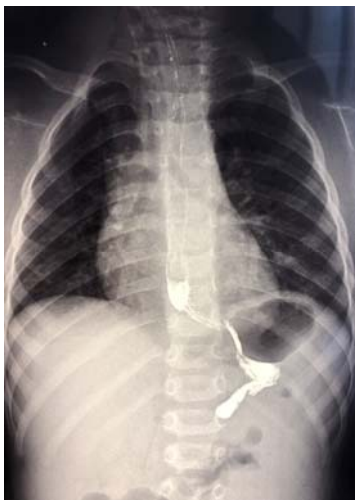

Fig. 5. Patient I.M. Chest and abdominal X-ray on the 30th day postoperatively.

At the admission clinical examination revealed a satisfactory general condition without deficit of body weight, the child was afebrile. From anamnestic data the child was born from the 2nd pregnancy without peculiarities. The child was born through normal vaginal delivery with a body weight of 3259 kg and a height of 48 cm. There were no problems in the perinatal period. Afterwards the child development was normal, but he had repeated respiratory infections from the first months of life.

The CBC (Complete Blood Count) reveals low erythrocytes (3,6x106 /L), hemoglobin -116 g/l, hematocrit – 34,0%, leucocytes – 11,5x109/L. The hydroelectrolyte balance, hepatic and renal function and coagulation tests were within normal range.

The chest and abdominal simple CT scan as well as CT scan with upper gastrointestinal tract contrasting, performed for differential diagnosis, confirmed the location in the posterior mediastinum on the right side of the stomach fundus and partially of the stomach body, the diagnosis of type III paraesophageal hernia being established (Fig.2).

After preoperative preparation the abdominal cavity was opened by the superior median laparotomy. On surgical exploration the gastroesophageal junction was discovered in the chest cavity. The partially twisted stomach (the greater curvature was anteriorly located) (Fig. 3A) was also positioned in the thoracic cavity through the esophageal hiatus, which was markedly dilated. The large hernia sac was located in the chest cavity with some adhesions to the parietal pleura and pericardium.

After total reduction of the stomach into the abdominal cavity the gastrohepatic ligament was divided and the mobilization of the hiatal defect and hernia sac were performed. The hernia sac was sectioned and excised excepted a small portion which was firmly fixed to the pericardium. After identification and fixation of the gastroesophageal junction the slightly dilated distal abdominal segment of the esophagus was mobilized, and the posterior crurorraphy was performed. To avoid the excessive tightening of diaphragmatic cruses and the mechanical stenosis of the esophagus in the hiatus the Collins maneuver was performed. The crurorraphy zone was enforced with equine pericardium acelular biologic graft (Bioteck Heart) fixed by interrupted sutures (Fig. 3B). Then the gastropexy by fixation of the fornix to the left hemidiaphragmatic dome and 180º partial anterior fundoplication was performed.

The postoperative evolution was favorable. After hydroelectrolyte resuscitation the patient recovered without any complications and was discharged on the 7th day postoperatively in satisfactory condition. The control X-ray on the 7th day postoperatively revealed normal pulmonary areas without any opacities, the stomach was located below diaphragm and the esophagogastroduodenal passage was good. At the Th8 level there was a small residual space in the chest cavity, where the herniated stomach has been, but not containing contrast material (Fig.4).

Discussions

Although the first reports about congenital and posttraumatic diaphragmatic hernia occurred in XVI-XVIII centuries, the first description of the HH as a clinical entity was published by Henry Ingersoll Bowditch in 1853, the first operation for that type of diaphragmatic defect was performed in 1919 by Angelor Soresi [5, 29, 30]. It's worth mentioning that the first description of the HH was probably done by Bright in 1836, who observed at the necropsy of a 19 years old girl a portion of the stomach localized in the chest cavity, the cardia being located at the

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level of Th4 [31]. The first radiographic evidence of a stomach dislocation in the thoracic cavity belongs to Austrian clinician Hans Eppinger (1904), the term "hiatal hernia" was introduced by Ake Akerlund (1926), who also proposed the radiologic classification of this pathology [30,32].

Paraesophageal hernias in children have several components. The defect is localized at the level of esophageal hiatus, covered by peritoneal sac, which extends to the right anterior side of the esophagus, as well as to the posterior mediastinum[23,33]. During migration the stomach tends to rotate around its axis (organoaxially), that could cause a partial or complete gastric obstruction between the above located esophagus and below situated duodenum [22].

In some cases HH could be associated with other congenital malformations such as diaphragmatic hernias [34], pulmonary sequestration [35], pulmonary agenesis [36], gastroschisis [37], gastrointestinal malformations such as short esophagus and microgastria [38, 39].

Usually the paraesophageal hernias in children are characterized by asymptomatic evolution, symptomatic cases manifest itself by recurrent respiratory infections, obscure gastrointestinal symptoms and anemia [6, 24]. Regurgitations and intermittent vomiting are the most frequent symptoms in children with HH [14]. In some cases the evolution of the paraesophageal HH could be aggravated by the development of severe complications including intrathoracic gastric volvulus [26], strangulation [40], incarceration and ulceration [4, 11]. The anemia in some cases could [41] be a manifestation of Cameron ulcer, which presents as linear lesions or erosions localized on the gastric mucosa folds at the diaphragmatic level. These lesions are determined by mechanical trauma during respiratory diaphragmatic contractions in combination with acid and ischemic injuries [42].

Prenatal diagnosis of HH established by ultrasound exam and MRI is of paramount importance and results in an early diagnosis of paraesophageal hernias in newborns which makes possible the surgical correction before the onset of complications [23].

In cases of paraesophageal hernias the imaging evaluation should be started with chest X-ray, which indicates the presence of abdominal organs in the thoracic cavity (usually gas bubbles). The contrast studies are performed to confirm the diagnosis and attested the full with contrast material stomach localized in the posterior mediastinum, often with an organoaxial volvulus [10, 22, 24]. The computed tomography is used to establish the definitive diagnosis, to assess the extent of the hernia content and to reveal affected lung complications [24].

The differential diagnosis of paraesophageal HH should be performed with pulmonary abscesses, congenital pulmonary cysts, hydatid cysts, pericardial cysts, esophageal duplications and epiphrenic diverticulum [22].

The paraesophageal hernia in children is an absolute indication for surgery, even in cases of incidental discovering or in the neonatal period, because of the high risk of potential fatal complications [6, 10]. There are some controversial issues regarding surgical approach in mixed paraesophageal HH [13]. Usually the abdominal approach through a superior median incision or right subcostal incision are preferred in children. These incisions allow an adecvated exposition of the subdiaphragmatic space. In some cases the thoracotomy could be used [22]. Lately more and more surgeons preferred the laparoscopic technique [43], even in the complicated forms of the disease [10].

Despite multiple controversies, the surgical treatment include the following elements: reduction of the hernia content into the abdominal cavity, hernia sac excision, mobilization of the distal esophagus to provide adequate length, closure of the hiatal defect, antireflux procedure and exploration for associated anomalies [24, 44].

Enforced hiatoplasty with synthetic or biologic protein grafts in paraesophageal hernias is an attractive option, with the aim to provide an additional resistance support for repaired esophageal hiatus, as well as safety of the reconstruction zone, decreasing the recurrence risk [45, 46, 47, 48]. In this context in the literature there are a lot of biologic materials used for this purpose in the adult surgery [49], including human acellular dermal matrix [50, 51], porcine small bowel submucosa [52]. However this problem is discussed rarely in pediatric surgery [53].

It is considered that antireflux procedure is a key element in the surgical treatment of HH, including paraesophageal hernias, because of the fact that anatomic and physiologic mechanisms of prevention of the gastroesophageal reflux are disturbed in this pathology [22, 54]. In children the Nissen 360º complete fundoplication is the gold standard, being the most frequent antireflux procedure used in the surgical treatment of gastroesophageal reflux [43]. As an alternative the partial antireflux procedures are proposed, including Toupet 270º posterior fundoplication, and anterior fundoplications on180º,120º and 90º. Techniques of partial anterior fundoplication differ from each other in terms of anchoring of the gastric fornix to the right diaphragmatic crus [55]. The most used are Thal [56, 57], Boix-Ochoa [58] and Watson [59] techniques of partial anterior fundoplication. In paraesophageal HH the advantage of partial fundoplication is the reduction of the risk of postoperative dysphagia, as well as anchoring of the gastric fornix to the right crus provides a support and stability of the hiatal reconstruction [60].

The recurrence rate of the congenital paraesophageal hernias is around 1,1%, the mortality rate varies between 0 and 20% and strongly depends on the associated comorbidities [60].

Conclusions

Type III paraesophageal hiatal hernia is a rare diagnosis, that could be identified incidentally because of the asymptomatic evolution, and a careful differential diagnosis, including thoracic cysts is needed. The partial torsion of the stomach that could be found in this mixed form of hiatal hernias has a high risk of severe complications development, which is a strong reason for

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planned surgery if the diagnosis is confirmed. Using of equine pericardial acellular grafts could be a suitable option for the hiatal defect repairing in paraesophageal hiatal hernias in children, but this technique needs an adequate follow-up regimen.

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THORACOSCOPIC EXCISION OF PRENATAL DIAGNOSED EXTRALOBAR PULMONARY SEQUESTRATION – CASE REPORT

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Abstract

Background: Pulmonary sequestrations are rare congenital bronchopulmonary malformation. Two types of bronchopulmonary sequestration have been described: intralobar and, extralobar sequestration. Case report: We present the case of a male patient with extralobar sequestration diagnosed prenatally and successfully treated by means of video-assisted surgical excision at the age of 7 months. Prenatal diagnostic of pulmonary malformation was suspected at routine ultrasound and confirmed on fetal MRI. The baby was delivered at 39 weeks of gestation by C-section. The diagnostic of extralobar sequestration was confirmed by CT scan performed at the age of 1 month. The child was asymptomatic so the surgical excision of the mass was performed after the age of 6 months by means of video-assisted thoracoscopy. The procedure was technical challenging but underwent flawless. The postoperative course was uneventful. Conclusions: Prenatal diagnostics is a very useful tool in planning and making appropriate therapeutic decision for patients with pulmonary sequestration. Video-assisted thoracoscopic excision is the optimal treatment option for extralobar sequestration.

Keywords: extralobar sequestration, pulmonary malformation, prenatal diagnostic, surgical excision, thoracoscopy

Introduction

Pulmonary sequestrations are rare congenital bronchopulmonary malformation. They consists of a mass of non-functioning pulmonary tissue that has no connection to the tracheobronchial tree [1]. Two types of bronchopulmonary sequestration have been described: intralobar sequestration (ILS), the non-functioning pulmonary mass is located within a pulmonary lobe, surrounded by normal pulmonary parenchyma and, extralobar sequestration (ELS) where the malformation is usually located inside the pleura as a distinct mass covered by its own pleura [2]. ELS can be found at any level in the pleural space and in rare instances it can be found within or beneath the diaphragm [3].

The major feature of pulmonary sequestrations is that the blood supply derived from the systemic circulation [2]. The arterial supply, most commonly emerges from the thoracic aorta (73%), the cranial portion of the abdominal aorta, celiac trunk, splenic artery, as well as intercostal arteries. The pathogenesis is related to abnormal budding of the lungs and, if the abnormal bud arises before the development of the pleura, it is invested with the adjacent lung and becomes an ILS. ELS develops after visceral pleural formation, it grows separately and acquires its own pleural covering [3].

ELS may be asymptomatic or may produce mass effect related symptoms or complications [2, 3]. In the past many ELS were incidentally diagnosed during a plain X-ray. Nowadays most of the bronchopulmonary malformations are detected prenatally, which offers better planning for the management and early treatment options [4]. Management options include non-operative treatment, surgical excision or endovascular treatment [5, 6, 7]

We present the case of a male patient with ELS diagnosed prenatally that was successfully treated by means of video-assisted surgical excision.

Case report

On the routine ultrasound examination at 24 weeks gravida III para II pregnancy, a large mass was noticed inside the left pleural cavity of the fetus, replacing or compressing the normal pulmonary tissue. A fetal MRI was performed at 29 weeks and the images showed a cystic mass 37/35 mm large at the base of the left lung (Fig. 1). The images were suggestive for pulmonary malformation and based on the presence of the cystic images inside the mass, Congenital Cystic Adenomatoid Malformation (CCAM) was suspected. Further ultrasound monitoring was carried on and the pregnancy course was uneventful.

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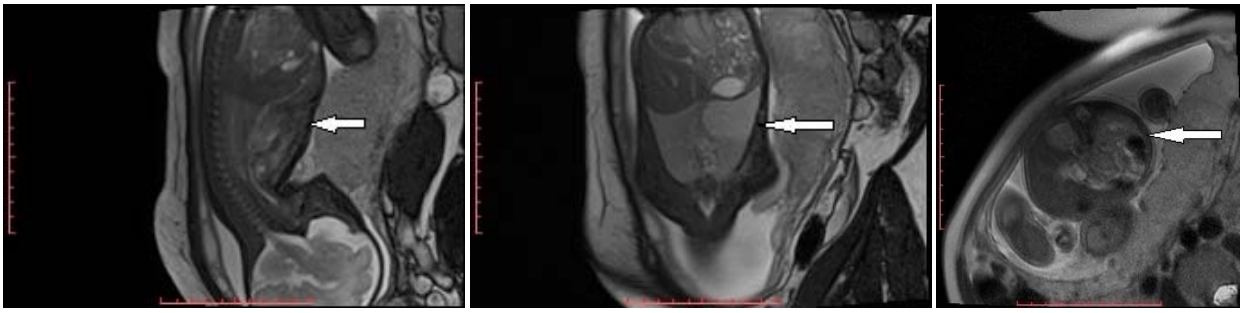

Fig. 1 A, B, C. Fetal MRI revealing a 37/35 mm mass containing cystic structure at the base of the left lung

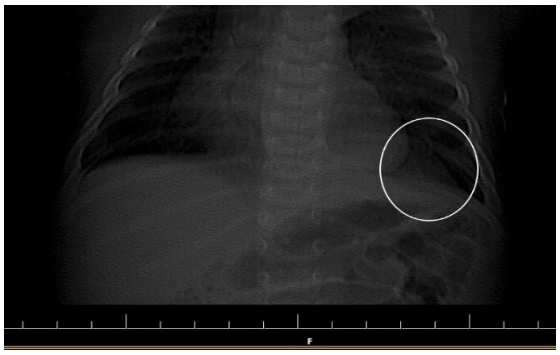

Fig. 2. Chest X-ray. Triangular opacity on the base of the left lung

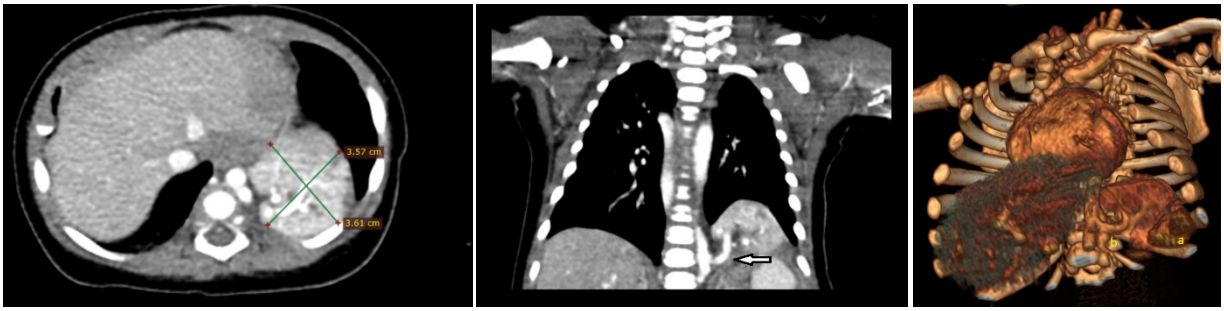

Fig. 3 A, B, C. Contrast enhanced thoracic CT scan with 3D reconstruction. Tumor is situated at the base of the left lung. Vascularisation from the descending aorta

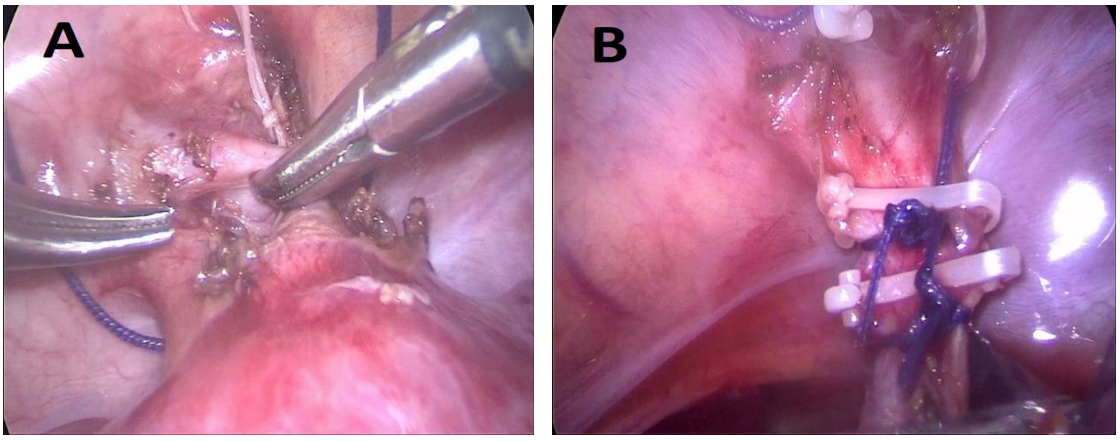

Fig.5 A) The blood supply: one artery that emerges from the descending aorta and a vein draining into the hemiazygos vein **B)** Vessels after ligation

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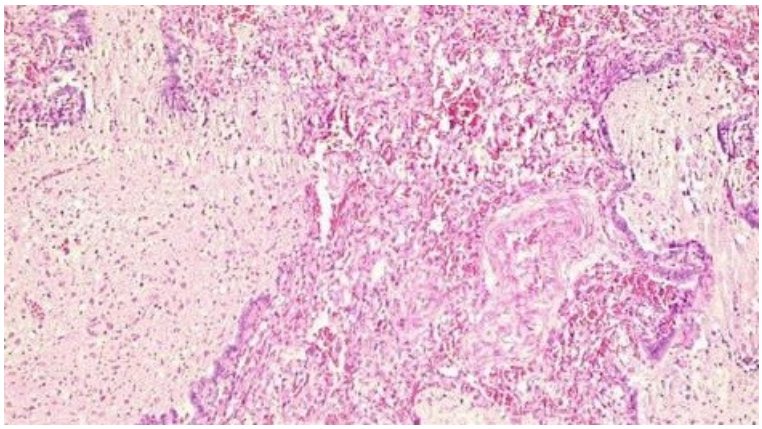

Fig .6. Cysts with mucinous content, lined by cylindrical ciliated epithelium, isolated muscle fibers, vascular structures with thickened walls, collapsed alveoli and hyperemiated vessels. Hematoxylin-Eosin stain, 10 X

At 39 weeks of gestation the male new-born child was delivered by caesarian section. The weight at birth was 3440g and the length 50cm. He was vigorous at birth, breathed spontaneous, without any sign of respiratory or cardiac distress. The Apgar score was 9 at 1min and 10 at 5 min. Clinical exam at birth was undistinctive except for the diminished respiratory sounds at the base of the left hemi-thorax. A chest x-ray was performed and revealed a triangular opacity at the base of the left lung (Fig.2). Blood samples were collected and extensive lab work was carried out. The results were also unremarkable.

Contrast enhanced computer tomography was performed 7 days from birth and revealed a solid mass located inside the left pleura, at the base of the thorax, in close contact with the left lung, measuring grossly 40/35/35 mm, with an arterial vascular supply emerging from the descending aorta and a venous system that drains to the hemiazygos vein (Fig. 3). Based on this findings the diagnostic of extralobar sequestration was set.

The decision was to postpone surgical treatment at least until the age of 6 months. Clinical follow up was carried on monthly bases and the clinical course was uneventful.

At 7 moth of age 7 kg of weight and 57 cm height the infant was admitted for scheduled surgical excision of the sequestration.

The child was placed under general anesthesia with oro-tracheal intubation. He was positioned on right lateral decubitus with the left arm in 900 abduction. A five 5mm optic port for was placed in 4th intercostal space on the posterior axillary line. Two 3 mm working ports were placed, one in the 5th intercostal space 3 cm posteriorly from the posterior axillary line and one in the 7th space on the anterior axillary line. The mass was identified at the base of the left lung. It was well-marked, purple, and had no connection with pulmonary parenchyma. The mass had an arterial supply coming from the thoracic aorta and a vein draining in the hemiazygos system. The vessels were covered by the parietal pleura, both were short intimately stick to each other. After difficult and meticulous dissection both vessels were ligated using hemlocks plus additional braid suture and then cut (Fig. 5). The mass was placed in an endobag removed through the anterior axillary line incision enlarge to app. 20 mm. A pleural tube was placed and maintained for 48 hours.

The histopathological examination, showed a modified architecture, presenting cystic spaces of variable dimensions covered with cylindrical/cubic ciliated epithelium, fibrous connective tissue with mucinous content, diffuse and chronic infiltrate, along with collapsed alveoli (Fig. 6). All of this are suggestive for a pulmonary sequestration, associating a nonspecific chronic inflammatory process.

Follow up visits were performed up to 6 months after surgery and revealed an uneventful postoperative course of the case.

Discussions

Pulmonary sequestration refers to an aberrant formation of segmental lung tissue in the embryonic period that has no connection with the bronchial tree [2]. Of the two types of pulmonary sequestration, the extralobar variant is the less frequent [3]. Most patients with extralobar sequestration are asymptomatic beyond neonatal period. Depending of the size and location of the mass it may produce chronic cough, frequent respiratory infections, compression and/ or functional impairment over nearby structures [5].

Nowadays most of the pulmonary malformations are diagnosed before birth by ultrasound [4, 8]. Antenatal diagnostic is a very useful tool because it can indicate the size, the consistency (solid/mixed lesions), it offers predicting factor for the postnatal evolution of the malformation [8]. In our case, the diagnostic of pulmonary

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malformation was suspected at the routine ultrasound. Fetal MRI gave us a more accurate picture of the lesions, sixe, location, structure, the relation with normal lung tissue. Our decision to carry on with the pregnancy until term was based in these information. However, neither antenatal ultrasound nor the antenatal MRI could offer an exact diagnostic for the mass. They could not differentiate between am intralobar or extralobar lesion. Moreover, the presence of the cystic structures inside the mass was suggestive for CCAM rather than an ELS. So the final diagnostic of ELS was made 1 month after birth by computed tomography. Contrast CT is the best imaging tool for the postnatal assessment of pulmonary malformations and in ELS the pathognomonic finding is the identification of the systemic blood supply [9].

Most of the ELS patients are asymptomatic at birth [10]. When symptomatic, they are usually treated by surgical excision. For asymptomatic patient, there is no consensus over the benefits of the surgical excision of the pulmonary sequestration. Several authors advocated against any form of therapy in children with Asymptomatic ELS, emphasizing that ELS tend to regress spontaneously after the age of 4 years [5, 11, 12]. In our case, the decision of performing surgical excision was based on the relatively large size of the intrathoracic mass and uncertainty of the lesion type. Prenatal MRI revealed cystic structures inside the mass which are suggestive for CCAM. Even though the diagnostic of ELS was clear due to the visualization of the systemic vascular supply, there still is the possibility of a mixt CCAM – Sequestration lesion. Regarding the timing for surgery, we decided to perform the surgical procedure after the age of 6 months in order to avoid an unnecessary stress in a young asymptomatic infant and to have sufficient working space to perform the procedure by minimal invasive means. Other authors reported significantly higher morbidity if surgery is performed in children younger than 3 months [6].

Video-assisted thoracoscopic surgery is effective has low grades of complication and conversion [13]. Even though, demanding from the technical point of view, the surgical excision of the ELS in our case went flawless. The main challenge was to isolate, ligate the vessels and safely cut them. Further on the mass was removed without difficulties through an enlarged incision at one of the ports sites. The benefits of the minimal invasive approach were evident in the postoperative course, less pain, fast mobilization, small incision, better esthetics. As previous reports we found that Video-assisted removal of ELS is a feasible and with clear benefits for the patient but it should be performed only by experienced surgeons because of the potential risk of life-threatening vascular injury [14].

Conclusions

Prenatal diagnostics is a very useful tool in planning and making appropriate therapeutic decision for patients with pulmonary sequestration. Video-assisted thoracoscopic excision is the optimal treatment option for ELS. However, the procedure is technical demanding and shall be performed only by experienced surgeons with enough experience in minimal invasive surgery.

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INJURIES ASSOCIATED WITH FIREWORKS – A REAL THREAT AMONG CHILDREN POPULATION

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Abstract

People use fireworks to celebrate religious and other holidays in many countries around the world. Fireworks have been banned in a lot of countries but still pose a high potential risk of injuries, especially among male children. Hands and fingers sustain the largest number of injuries followed by legs, then eye injuries. In addition, the lesions from fireworks can be "life-changing" if it occurs on someone's dominant hand, which may never regain its original function if the injury is very severe, or if it produces loss of vision.

Keywords: Fireworks, Injuries, Children, Legislation, Prevention

Introduction

Fireworks are devices with origin in ancient China and they contain combustible chemicals that cause explosives [1], bright and colorful effects. They contain sulfur, charcoal and gunpowder, and the red-hot fragments can reach more than 1,300 degrees, according to the CPSC (Consumer Product Safety Commission in the USA). They are used in many countries around the world to celebrate different festive occasions related to reiligious traditions, historical or cultural events. Examples include Independence Day in the United States, Guy Fawkes' night in Australia, Britain and New Zealand, Deewali in India, New Year in China and Italy, Prophet's birthday in Libya and Hari Raya festival in Malaysia [2]. In Romania, fireworks pose serious problems during Christmas or Easter Holiday and New Year's Eve.

Purpose

Children are in high risk of injury from fireworks and represent more than 30% of emergency room visits for fireworks-related injuries. Children between the ages of 5 and 9 years are more than twice as likely as people in other age groups to be injured by fireworks [3]. Other studies say that adolescents, especially boys are more affected. Boys' injuries are usually self inflected, while injured girls are usually bystanders [4].

In Romania there are no studies with reference to fireworks. The legislation has existed since 1995, but illegal sales and imports increase especially during the Christian holidays and the end of the year, when unsupervised children are victims of these devices. We want to describe as an example the case of an adolescent boy admmited in the Clinic last year arround Christmas Eve with a hand injury after a firework explosion while holding the device. As a complement to the lesional framework, we wanted to describe the legislative state and to present certain safety rules in handling these devices.

Material and method

The case that we wanted to present is an 11 year old boy who came in the Emergency Room and then was admitted in our Department for write hand lesions after a firework explosion while holding it in his hand. He had severe blast lesions in his palm and of his thumb, with nail loss. The soft tissue of the first phalanx of the index, including the nail, were amputated, exposing the bone (figg. 1-4).

He went immediately in the operating room, where, under general anesthesia we've done an amputation of the first phanlanx of the index and also of the distal interphalangian joint. The remaining soft tissue was used to close the amputation site. After repeated dressing every 24 and then 48h, in 4 weeks the result is shown in figg. 5-7.

Results

The end result in this case was a good one, without serious injuries that can lead to a severe functional disability, such as blindness or amputation of important parts of the hand or even the entire hand. This boy will manage to use the right hand with no difficulty, even for writting.

Such cases, as an example, must lead the authorities to get more seriously involved in the problem of fireworks and all so-called explosive entertainment devices that can cause severe injuries, if handled by unauthorized persons, especially children, and in inappropriate environments.

Romanian law divides firework devices in 4 classes [5]. Objects from first class can be selled all year long, second class only between 27th -31th of December and can be used only on the 31st of December and 1st of January. Pyrotechnic devices in classes III and IV may be handed over and put into use only to persons authorized as pyrotechnicians.

For the organization of fireworks with pyrotechnic objects from the 3rd and 4th classes, the approval of the county police inspectorate, respectively of the General Police Department of Bucharest is required. Fireworks with pyrotechnic objects from the 4th grade can be performed only by specialized persons, authorized by law, with all measures taken to prevent fires.

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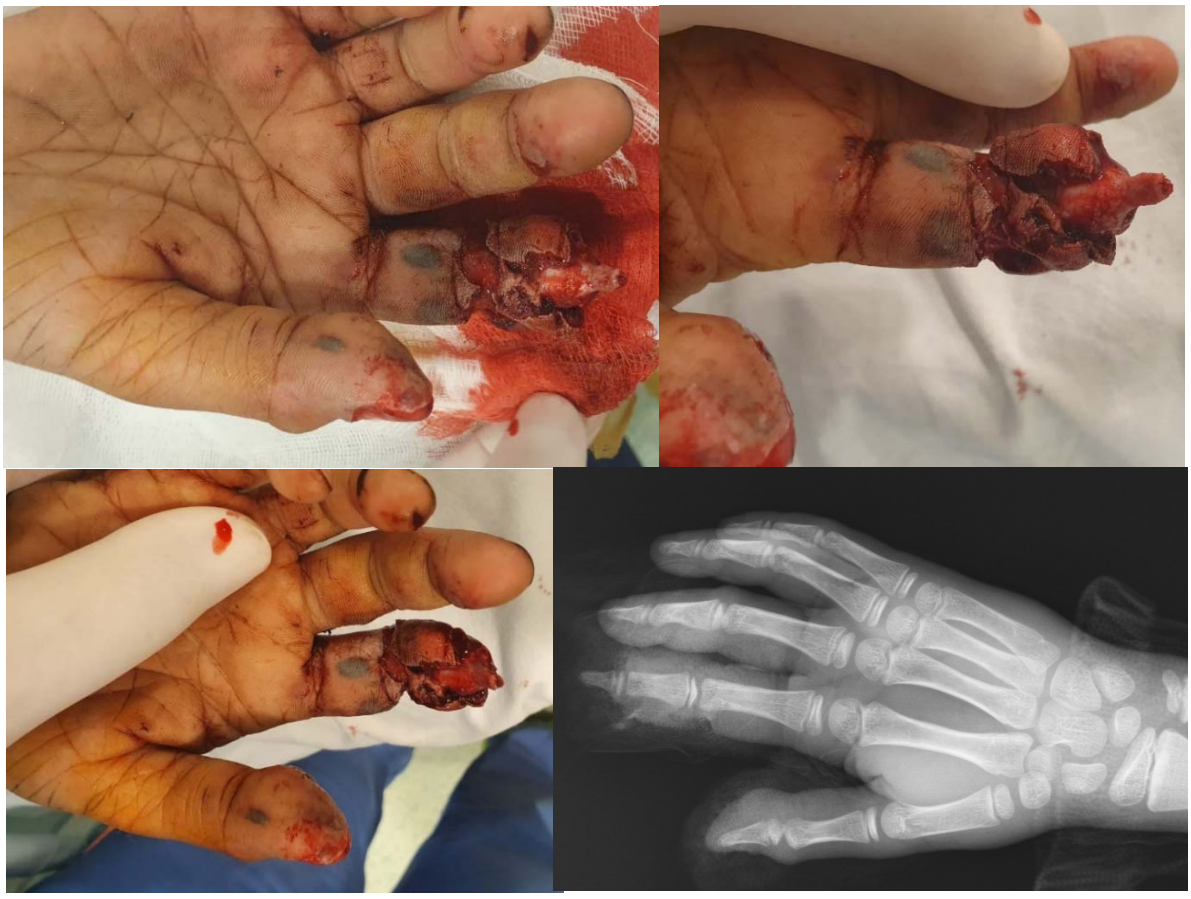

Fig. 1-4.The aspect of the right hand after firework explosion, including the Xray

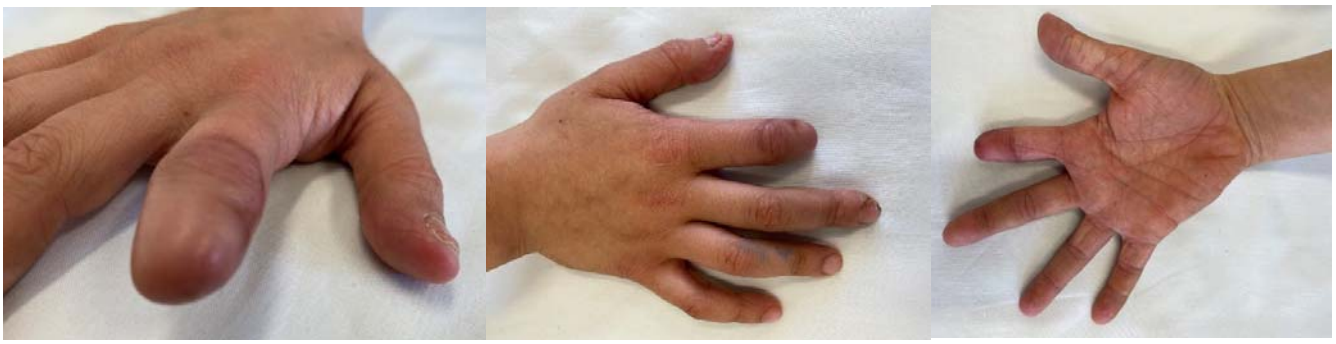

Fig. 5-7. The result after one month from surgical treatment

In order to prevent fires and to ensure operative interventions, the organizers of fireworks with pyrotechnic objects from classes III and IV must notify the local fire service 24 hours before their conduct.

All these safety and accident prevention measures are not enough if the population is not properly informed through various media, such as the press, television, radio or authorized brochures, so that the danger itself can be fully realized.

During the winter holidays and Easter, illegal traders sell pyrotechnic products of dangerous grades without approval or precautions. These products also end up in the hands of unsupervised children who become direct victims of injuries caused by uncontrolled explosions or may cause other indirect victims.

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Studies say that most of the injuries caused by pyrotechnic products and hospitalised, were caused by firecrackers and sparklers [2]. Basically a law cannot totally prevent the population from obtaining and using fireworks. Injuries due to fireworks can result from both legal [6] and illegal ones [7,8]. In order to develop safety measures, the type of fireworks causing injuries should be punctiliously studied and a comprehensive approach is necessary [9-14]. Recommendations include parental education and supervision at home during holidays like Easter and Christmas or New Year's Eve, and only attending formally organised fireworks displays [12,15].

Legislation has a significant effect on injury rates. In some states in America, were the law was permissive, injury rate was seven times greater [12]. In Hungary, incidences were reduced following a 'legislative ban on private fireworks displays' [13].

Many studies recommend the introduction of stricter regulations and banning the sale of pyrotechnic objects. There should also be greater control of sellers and encouraging the population to use only approved fireworks and sites. School education has to be supported and developed [16].

Conclusions

Fireworks are associated with serious injuries. Hands and fingers are more affected; other body parts affected by firework accidents are the legs and eyes, followed by the head, face, ears and arms.

It is important to know that most of these injuries among pediatric age group can be preventable. Fireworks must not be given to children even in safe public sites.

Legislation must be more severe and the competent authorities must closely monitor its observance both during the festive seasons and throughout the rest of the year. Also parental supervision and school education are also needed to prevent injuries from pyrotechinc devices.

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ESOPHAGOGASTRODUODENOSCOPY: A BINDING TOOL FOR FOLLOW-UP OF ESOPHAGEAL ATRESIA PATIENTS

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Abstract

Follow-up of pediatric esophageal atresia (EA) patients in Romania is relatively difficult due to insufficient access to proper tools and special trained health professionals. We address this paper to increase the consciousness in the both medical and patient community over the relevance of providing close upper endoscopic evaluation in EA children so the best results in long-term complications identification and treatment may be obtained. Possible critical complications in infancy, longstanding to adult life can be averted by prevention and a well-standardized evaluation plan. A series of 4 cases operated and currently followed up for EA in our clinic were selected. Their history, radiologic and endoscopic evaluation are pointed out willing to extract conclusive observations over the esophagoduodenoscopy position in these patients. The most frequent condition following EA surgery is gastroesophageal reflux disease (GERD). Treatment of GERD should be tailored accordingly to its extent, nature and long-term evolution in order to avoid unnecessary surgery. Left unidentified, incompletely evaluated and subsequently treated this may lead to serious complications like epitheal metaplasia or peptic esophageal strictures in which using flexible esophagoscopy and a good focus over the the esophageal configuration and dilatations should be the prime option of their treatment. Upper endoscopy is required to be regularly considered in a constant standardized follow-up of EA patients, depending on their evolution, from the early ages to adulthood, thus a good quality of life is ensured and – in latter life - a better transition to adult medical or surgical care is done.

Keywords: Esophageal atresia complications, endoscopy, gastroesophageal reflux, esophageal stricture

Introduction

"A monstrous birth in Plymouth" had been described in 1670 by Durston who was mentioning in his necropsy report "the oesophagus from the mouth of the right head descended no lower than a little above half an inch off the midriff, and there it ended" in a female thoracopagus twin [1]. 199 years after, Holmes suggests that an attempt of esophageal atresia (EA) repair may be made. In 1939 Ladd and Leven have reported the first operated esophageal atresia survivors triggering the ascension of EA surgical treatment outcomes together with the progresses made in neonatal intensive care. Therefore, in 1962 The Lancet journal has published Waterston's paper studying 218 EA infants and considering birthweight, pneumonia and existence of associated congenital anomalies prognostic factors for survival [3] and later, in 1994, Spitz reconsiders these specifying only birthweight and the existence congenital heart anomaly as patients at risk [4]. Later on, in 2009, a team Okamoto T. revisits Spitz's classification and reconsiders stratification of EA patients' survival depending only on birthweight and major cardiac anomalies [5].

Accompanying the progress made in EA patients' survivability, Puri's observations over the possibility of delayed primary anastomosis following spontaneous growth of esophageal segments in EA in 1981 [6] and - in 1992 – the positive outcomes after applying this principle [7] constitute a huge twist in EA surgical treatment, esophageal substitution becoming subsidiary and a new vision over the follow-up and late complications of these patients has quickly emerged. Most pediatric surgeons consider today that native esophagus preservation provides the most physiological results in matter of reconstruction. In consequence, the challenge of the esophageal gap - associated to the surgeon's ambition toward primary esophageal anastomosis - is also a harbinger for gastroesophageal junction displacement into the thorax, leading practically to cardia incompetence, long-term GER and strictures in most of the cases [8]. Nevertheless, surgical repair of esophagus itself disrupts the esophageal motility leading to dysmotility who to its turn leads to a greater chance of developing gastroesophageal reflux (GER) [9].

Material and method

Personal observations disclose a difficult follow-up and proper diagnosis of EA complications in Romania. This may be associated to the low parents' compliance, their poor health literacy, but also by a burdensome access to specialized health care (pediatric gastrointestinal endoscopy) because of defective medical infrastructure, lack of high-performance devices and specialized pediatric health professionals. Throughout this paper we wish to raise the awareness among both pediatric professionals and patient population over the fundamental role played by upper endoscopy as a follow-up, diagnosis and treatment tool in long term esophageal atresia management.

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In this manner, a series of 4 relevant cases in our clinic's experience in evaluation of long-term EA complications. We bring into discussion their history, radiologic or endoscopic features, emphasizing on the contribution upper endoscopy has made in these willing to point out its value.

Results

Case 1

A 10 years old male patient is admitted for his first endoscopic evaluation 8 years prior transverse colon esophageal replacement procedure for EA. He doesn't report any feeding or swallowing difficulties or history of GERD symptoms. Last esophagogram obtained doesn't objectify episodes of GER. Upper endoscopy is performed noticing persistent biliary reflux at the distal level of the colonic graft. Even more, intestinal metaplasia changes (glandular layout accentuation) are noticed at the level of distal esophageal-colic anastomosis (Fig. 1). Biopsy specimens are obtained and the diagnosis is histopathologically confirmed.

Case 2

A 4 years old girls known with postoperative GER after delayed primary anastomosis for EA is admitted for her second esophageal endoscopic evaluation. Diagnosis of grade B (Los Angeles) erosive esophagitis in a previous evaluation 6 months before current evaluation. Mucosal tears healing could be evaluated and the healing process confirms the efficacy of proton pump inhibitor dosage adopted so far (Fig. 2).

Case 3

An exceptionally rare case of a 4 years old female patient with esophageal atresia with distal tracheoesophageal fistula (TEF) associating congenital microgastria is managed in our pediatric surgery clinic. Ligation of the fistula and gastrostomy were done at birth and delayed primary esophageal anastomosis was performed after. High persistent GER in association with peptic anastomotic stricture quickly developed and re-do anastomosis had to be done. The gastric malformation was corrected at 1 year old considering a Hunt-Lawrence gastric augmentation procedure and replacement of the gastrostomy. During the follow-up, esophageal anastomosis stricture recurs, but patient's age and weight allows establishing a safe Savary esophageal dilatation treatment plan. Long term high dose PPIs is adopted complementary because of persistence of high GERD. Routine barium meal was done after apparently a favorable outcome of esophageal dilatations in order "to avoid unnecessary anesthesia" and opportunity of gastric tube removal showing a satisfying aspect of the esophageal anastomosis. However, the patient is shortly readmitted after the radiologic evaluation with dysphagia, upper esophagus food impactation and a punctiform esophageal stricture (Fig. 3). After dilatation of the anastomotic stricture a second stricture could be visualized endoscopically presenting a voluminous hiatal hernial below with passive gastric content reflux (Fig. 4). The patient is currently under endoscopic surveillance and dilatations following spontaneous evolution of GERD.

Case 4

An 11 years old male is admitted in the pediatric surgery clinic for dysphagia. History of the patient relates: primary esophageal anastomosis for EA with distal TEF and re-do procedure for esophageal anastomosis stricture in his first year of life which quickly recurred and required gastrostomy, further on being treated by Foker tractions and Nissen fundoplication in a pediatric surgery clinic abroad. When the second esophageal anastomosis is attempted dehiscence occurs and the patients' parents decide to come to our clinic where a third re-do esophageal anastomosis is complicated shortly after by stricture formation. The parents decide to follow dilatation treatment through rigid esophagoscopy in the ENT department with a satisfactory outcome on barium swallow evaluation imagery and in matter of quality of life – "the kid eats well, sometimes he chokes shortly, but he handles it". The patients present to pediatric surgery department and flexible endoscopy is done for the first time: eccentric esophageal stricture with giant pre- anastomosis stricture diverticula formation is noted (maybe due to blind rigid esophagoscopic dilatation), high quantity of partially digested food residue in the diverticula (Fig. 5). After Savary dilatation is done the endoscope can be advanced through the anastomosis and Los Angeles grade D erosive reflux esophagitis is demonstrated (Fig. 6). Re-do anastomosis was done considering the refractory diverticulum excision and dilatation program and high dose GERD treatment plan is currently considered.

Discussions

More than 90% of the EA patients survive today, their only poor prognostic being dictated solely by severe cardiac malformations or low birth weight. Nearly half of the patients present GER up to 10 years after primary esophageal reconstruction and 25% to 75% of the adults and children with repaired EA associate chronic GER symptoms. 53% of long-term followed-up EA patients present erosive esophagitis and they have a 4-fold higher risk than normal population of developing Barrett's esophagus [10]. Moreover, Sri Rapan reports in 2007 an incidence of the strictures of 76% in delayed primary esophageal anastomosis of which 23% needed resection [8]. Esophageal adenocarcinoma has also been scarcely reported in the literature following EA repair [10].

Gastroesophageal reflux disease (GERD) clinical picture is often subtle in children and barium contrast study in its follow-up and diagnosis is not recommended due to its low sensibility and specificity. GERD may be hidden under less specific symptoms like dental erosions, chronic cough, raspy voice, recurrent pneumonia or otitis, apnea, asthma, chronic anemia, Sandifer Syndrome or failure to thrive [11]. Upper endoscopy with or without tissue biopsy may detect and follow-up GERD development throughout macroscopic evaluation to minor microscopic architecture modifications, some of them of substantial importance like intestinal metaplasia or Barrett's esophagus.

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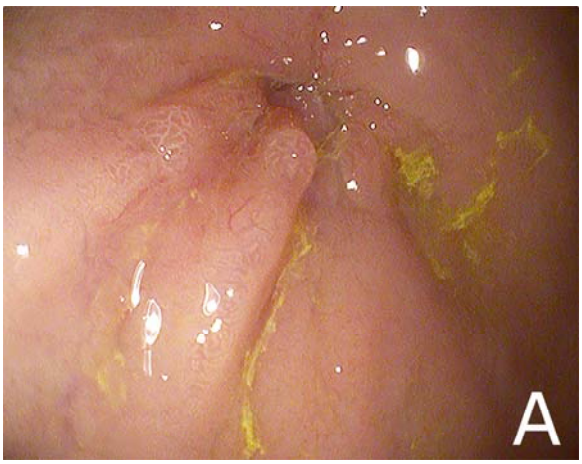

Fig. 1. Intestinal metaplasia change

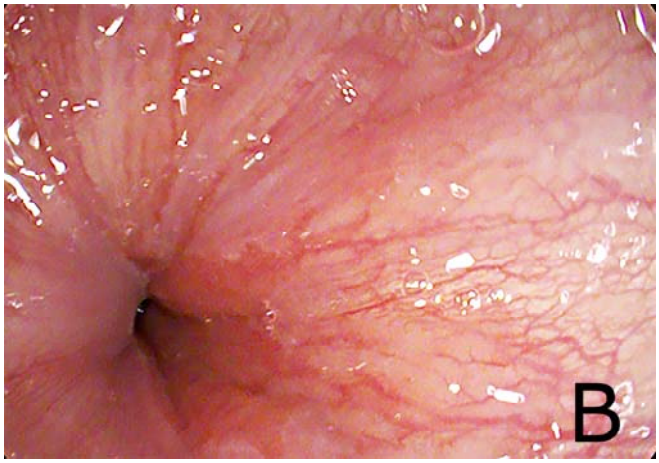

Fig. 2. Mucosal tears healing

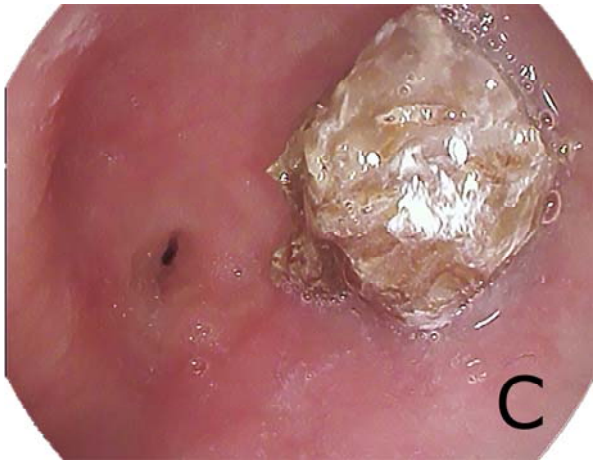

Fig. 3. Upper esophagus food impactation and a punctiform esophageal stricture

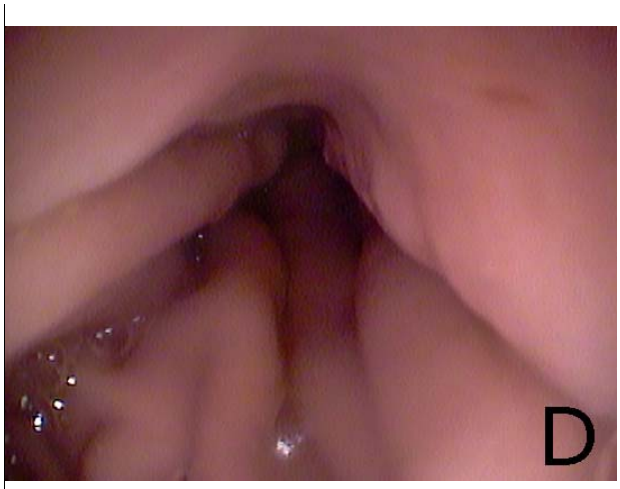

Fig. 4. Voluminous hiatal hernial below with passive gastric content reflux

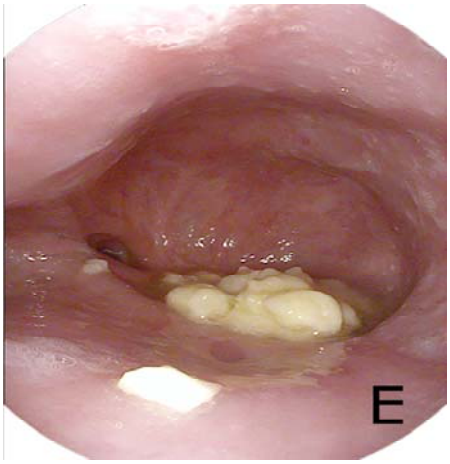

Fig. 5. Excentric esophageal stricture with giant pre- anastomosis stricture diverticula

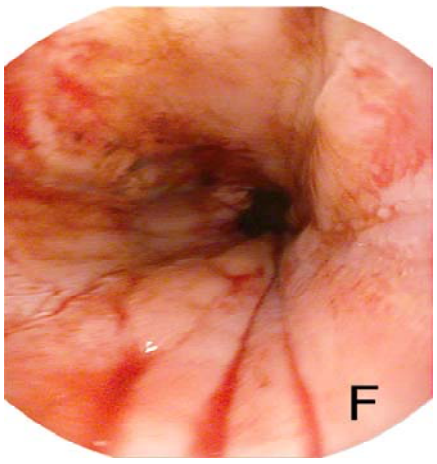

Fig. 6. Los Angeles grade D erosive reflux esophagitis

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Postoperative endoscopic assessment of EA patients is recommended even if the symptoms are regardless [12]. By resemblance, later in adult life, even if the patients report a very good quality of life or absence of GERD symptoms, this is not an indicator for a healthy esophagus and asymptomatic patients are often reported presenting severe forms of GER. There's also a proof of a poor relationship between subjective GER symptoms and pathological GER identified at pH-metry [13].

Anastomotic stricture formation process in EA may be intensified by the presence of gastric juice. GER is precipitated by displacement of the esophagogastric junction while mobilization the distal esophagus and by esophageal dysmotility related to EA. [9, 14]. Contact with acid fluid seems to intensify regeneration process from which a higher chance to develop an anastomotic stricture. Moreover, chronic exposure to acid secretions may induce de novo peptic strictures. Therefore, PPI treatment is routinely recommended after an EA anastomosis, even if the patient doesn't present any signs of GER. A considerable amount of EA patients (8-15%) still deal with anastomotic strictures in adulthood. When you deal with an anastomotic stricture esophageal dilatation using flexible endoscopy should be the first line of treatment [14]. Dilatations are most often required the first two years after primary repair [15]. Bougie or balloon dilators can be used, but currently there's no strong evidence if one or other is more efficient and, therefore is all up to the endoscopist's experience and comfort. In case of recurrent or refractory anastomotic strictures, several adjuvant methods are known: systemic or intralesional steroid therapy, intravenous mitomycin C, endoscopic electrocautery insicional treatment or esophageal stenting. Surgical management like stricture resection or esophageal replacement should be reserved for exceptional refractory cases [14].

EA patients represent a special subgroup when it comes to indication and type of anti-reflux surgery. Wrap failure is more common in these patients, even if initially there is a prompt symptoms' relief. There are not enough scientific proofs to delineate the efficacy of a complete wrap versus partial wraps, but the surgeon should always keep in mind the dysphagia, retching or gas-bloating a Nissen fundoplication may lead to and balance this with the infant's natural evolution of GERD, esophageal dysmotility, coexistence of strictures or delayed gastric emptying. Accordingly, long term PPI with a close follow-up of its efficacy should always be considered before any indication of anti-reflux procedure [16].

In addition, evaluating esophageal strictures through direct flexible endoscopy a full image over the whole esophagus anatomy, the stenosis elasticity, localization, associated anomalies (like large upper pouches, hiatal hernia, esophageal diverticula) while U-turn evaluation of the gastric fornix may bring relevant information about the looseness or efficacy of the anti-reflux procedure.

Conclusions

Endoscopy should be considered a gold standard tool for long-term follow-up and treatment in EA children and it should be integrated systematically in EA management protocols.

A more meticulous detailed long-term evaluation of EA leads to a better prevention of imminent complications, consequently a better quality of life and, nevertheless, a soft and clean transition of the patient to adult healthcare professionals.

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INTRA-ABDOMINAL UNDESCENDED TESTICLE: CURRENT TRENDS AND MANAGEMENT

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Abstract

Cryptorchidism or undescended testicle (UDT) is one of the most common congenital anomaly in boys. Cryptorchidism occurs in approximately 3% of male newborn children and increases significantly in premature newborns. The complications of a UDT includes: testicular torsion, testicular cancer and infertility. The correct and cautious treatment significantly reduces the rate of these complications. The best treatment of UDT remains controversial nowadays, both for the palpable testicle and especially for the non-palpable testicle. Laparoscopy has a special advantage in the management of the intra-abdominal testicle: both from a diagnostic and therapeutic point of view. In this article, we analyzed current trends in the diagnosis and treatment of the intra-abdominal testicle.

Keywords: undescended testicle, intra-abdominal testicle, laparoscopic treatment

Introduction

Cryptorchidism or an undescended testicle (UDT) is one of the most common congenital anomaly identified at birth, at boys. Cryptorchidism is defined as a testicle that is not located in the scrotum and cannot be manipulated in it. UDT occurs in approximately 3% of male newborn children. Because the testicle usually descends in the seventh month of gestation, the incidence of cryptorchidism increases significantly in premature newborns, [1, 2].

History

Cryptorchidism was first described by Baron Albrecht von Haller and John Hunter. First surgical attempts of correction of the undescended testicle were in the early 1800s, and the first successful orchidopexy was performed by Thomas Annandale in 1877. It became a routine procedure in the 1950's and early 1960's. Diagnostic laparoscopy for impalpable testicle was first carried out in 1976 by Cortesi et al. Scott reported the first series on pediatric laparoscopy on impalpable testicle in 1982 and Jordan et al. introduced the therapeutic application of laparoscopy on boys with impalpable testes in 1992[3,4].

Embryology

It is essential to understand how the abnormalities of the testicular formation can give different disorders, such as, cryptorchidism, testicular tumors or abnormal spermatogenesis.

The sex-determining genome is located on the short arm of the Y chromosome- SRY gene (sex-determining region Y). Mutations in this gene can lead to a range of sex-related disorders with varying effects on an individual's phenotype. Starting with the six week of gestation, the SRY protein initiates a cascade of events leading to differentiation of male reproductive structures. Without these events, the embryo follows the default development pathway, forming female internal and external genitalia [5].

The testicle descends normally from the abdomen to an extracorporeal position (scrotum). The testicular descent takes place in two stages, between 8 - 35 weeks of gestation: the first phase also known as the transabdominal phase and the inguino-scrotal phase. The first phase lasts from 8th to 15th week of gestation ad represents the enlargement of the gubernaculum. There are known two important hormones in testicular descent: insulin-like factor 3(INSL) and testosterone, both secreted by the testicle. INSL3 stimulates the enlargement of the genito-inquinal ligament, or gubernaculum. If the first phase fails, the testicle remains intra-abdominal. Other potential mediator of descent include Mullerian inhibitory factor (MIF) by causing resorption of Mullerian structures and clearing anatomic roadblocks to descent [5, 6].

The second phase of testicular descent starts around the 25th week of gestation and the gubernaculum reaches the scrotum at the 35th week. The gubernaculum acts as a guide wire for the scrotal descent of the testicle. This phase is more commonly disrupted as it is more complex, leading to localization of the testicle between the deep inguinal ring and the scrotum [5, 6].

Genetics

Several genetic studies, conducted on animals revealed that there might be link from certain genetic disorders and cryptorchidism. It was found that damaging of INSL3 encoding gene in mice leads to impairment of transabdominal descend of mice testes with subsequent cryptorchidism [7]. However, until larger studies are performed, the most commonly identified genetic defects associated with cryptorchidism will remain those that affect androgen production or action.

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Cryptorchidism is clustered in families, which suggests a genetic or intra-familial environmental cause. Monozygotic and dizygotic twin brothers have similar concordance for cryptorchidism, suggesting a minor role for genetic factors. Full brothers have a lower risk than twin brothers if one of the boys has cryptorchidism, but their risk is higher than that of half-brothers. Maternal half-brothers have a higher risk than paternal ones [1, 8].
The undescended testicle is commonly found in syndromes such as Prune Belly Syndrome, Noonan Syndrome, Koolen-de Vries Syndrome, Rubinstein-Taybi Syndrome, Meier-Gorlin Syndrome and others

Classification

Undescended testicle are most commonly classified in palpable and non-palpable testicle. The division into palpable and non-palpable testicle may offer the clearest categorization for management purposes, the treatment depending on the location of the testicle at the time of examination. Approximately 80% of UDT are palpable. The non-palpable testicle includes the intra-canalicular, intra-abdominal or absent testicle [8, 9].The intra-abdominal testicle represents 50-60% of the total non-palpable testicle. It can be located in different positions, being most often found very close to the internal inguinal ring. Other possible locations include the kidney, the anterior abdominal wall and the retro-vesical space [10-15].

Another classification of the intra-abdominal testicle concerns the position of the testicle regarding the internal inguinal ring as follows: more than 2.5cm or less [16].

Diagnostic of the intra-abdominal testicle

Diagnosing the intra-abdominal testicle is based mainly on clinical history and examination. Paraclinical investigation can also be helpful but not as a routine. [17]

Medical history.

The anamnesis should include data about the course and duration of pregnancy, as well as birth weight, position of testicle at birth, other defects and diseases of the child and family history [18].

Physical examination.

Clinical examination plays an important role in the diagnosis of the intra-abdominal testicle and should be performed in a warm room, with a warm hand and the patient should be examined in both supine and standing (for older boys) position. Palpation is a basic technique to examine UDT. Gonads should be carefully examined for size, turgor, any palpable para-testicular anomalies, or inguinal and scrotal disorders [19, 20]. The clinical examination of both testicles plays an important role in the diagnosis and must be performed as standard. It could be helpful to also perform a clinical examination in the operating the place with the child under general anesthesia just before surgery. This gesture may avoid unnecessary diagnostic laparoscopy [2].

Imagistics

Paraclinical examination cannot definitely determine the absence or presence of the intra-abdominal testicle. Ultrasound lacks the diagnostic performance to detect the testicle for sure or to establish the absence of an intraabdominal testicle. The use of different methods of paraclinical investigations such as ultrasound or MRI for the non-palpable testicle, is limited to suspected cases of disorder of sex development. Current guidelines do not recommending as a routine the use of ultrasound or other imaging methods. In most of the cases they do not change management plan and do not add accuracy in diagnosing of a presumed intra-abdominal testicle [21, 22, 23].

In conclusion, the diagnosis of the palpable or non-palpable testicle is recommended to be performed with the child under general anesthesia, this being the first step in surgical treatment of UDT

Management

The management of UDT aims to improve fertility, allowing the testicle to be more accessible for examination and detection of malignancy and alleviate psychological stress caused by empty scrotum. The main goal of UDT treatment consists in pulling the testicle down in the scrotum. European Association of Urology (EAU) recommend that the treatment should be performed between the ages of 6 to18 months. After this age, undescended testes rarely descend spontaneously. Early orchidopexy can be followed by partial catch-up testicular growth, which may not the case in delayed surgery.

There are two basic treatment methods for UDT: hormonal and surgical. [2, 18].

Hormonal therapy.

There is no consensus if the hormonal treatment with either HCG or GnRH are benefi-cial for children with undescended testicle. It can be administered as a neoadjuvant therapy prior to the orchidopexy or as a supplementary treatment after early surgery for UDT. Studies conducted show that only 8% of patients who underwent luteinizing hormone treatment had a palpable testicle after it was performed. Other hormonal analogues have not proven to be effec-tive in the testicular descending process, which is why, both American Urology Association (AUA) and European Association of Urology (EAU) do not recommend hormonal treatment. Currently, the EAU does recommend treatment with gonadotrophin-releasing hormone ana-logues for boys with bilaterally undescended testes for this purpose, but the AUA concluded that while this therapy may be found to be beneficial for further fertility, currently the long-term effect remains unclear [24,25,26]

Surgical therapy.

It is recommended that any procedure should begin with a re-examination under general anesthesia to reassess the presence of a testicle when the patient is relaxed [17]. All guides recommend exploratory laparoscopy for the intra-abdominal testicle, being nowadays the gold standard

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in making the diagnosis, having an increased sensitivity and specificity. Laparoscopy is both, a diagnostic and a therapeutic method in the management of the intra-abdominal testicle. The advantages of laparoscopy over the open surgery, classic approach of the intra-abdominal testicle, include not only a better exposure, but also an assessment of testicular position and viability. There is a never-ending debate about the type of laparoscopically assisted orchidopexy that should be used in patients with intra-abdominal testicle [26]

Some authors recommend a two-stage procedure for patients with high intra-abdominal testicle, with division of the testicular artery in the first stage and later, laparoscopic orchidopexy for the second stage. Other authors point out that dividing the spermatic vessels of the first stage do not reduce the risk of testicular atrophy and propose vessels division and orchidopexy in one surgical time [27, 28].

Surgical technique.

One-stage Fowler-Stephens procedure involves clipping and transecting the testicular vessels (Fig.1). Peritoneum above the testicular vessels is incised and dissected from the testicular vessels as high as required. Releasing the testicular vessels from the peritoneum and retroperitoneum allows extra mobilization of the testicle downward. Peritoneum over the deferens vas is not dissected. There is sufficient collateral arterial flow through the deferential artery to allow the testicle to survive. After mobilizing the testicular vessels by stripping off the peritoneum, the testicle can now be deposited in the scrotum. If there is any tension on the vessels, the peritoneum above the testicular vessels can be further dissected to a higher level laparoscopically. Single-stage laparoscopic orchidopexy for low-level undescended testicle has very good results. The testicular survival rate in the one-stage Fowler-Stephens procedure is up to 60% [29, 37].

Two-stage Fowler-Stephens procedure. The basic principles of this technique is similar with the one stage Fowler-Stephens. The difference is that the procedure is carried out in two stages. In the first step, the spermatic vessels are clipped at 3-4cm proximal to the testicle. The testicular vessels are isolated from the testicle by leaving the retroperitoneum up to the testicle and vas deferens undisturbed. The second step is performed 3-6 months later. During this period of time the "untouched" deferential vessels are allowed to grow and take over the main blood flow of the testicle. In the second stage the testicle is brought down and deposited in the sub Dartos pouch. The two-stage laparoscopic Fowler-Stephens approach is currently the most popular technique for intra-abdominal testes, with a success rate of 77–80% .[28,30,37]

Microvascular anastomosis. The testicle is approached through a laterally extended groin incision. The inguinal canal and peritoneal cavity are opened and the testicle delivered into the wound and freed from its peritoneal attachment. The dissection of the testicular vessels and vas is undertaken entirely retroperitoneal. The testicular vascular pedicle is mobilized by blunt dissection under vision as far proximally as possible towards the kidney and beyond the confluence of the pampiniform plexus to form a single large testicular vein. The vas is being mobilized deep in the pelvis, taking a particular care in order to preserve the delicate and easily damaging collateral vessels along with it. If following such an extensive dissection the testicle cannot reach the scrotum without tension, then the operative plan alternates to microvascular revascularization. The vessels are followed up beneath the rectus abdominis to provide a long vascular pedicle and a better diameter to match the testicular vessels (Fig.2). The inferior epigastric artery and one vein are clamped with graded microsurgical clamps and divided. The testicular vessels are divided high retroperitoneal and the testicle are placed in a previously prepared ipsilateral scrotal extra-Dartos pouch without tension. In the event of a short vas, it is occasionally necessary to pass the testicle beneath the remnant of the umbilical artery to gain further length of the vas and to avoid tension on the vessels [32].

Even though the success rate is up to 90%, the technique is not very popular among pediatric surgeons for several reasons, including the long duration of the operation and the need for microsurgical skill and special instruments [16, 31].

Shehata technique. The fundamental concept for this technique is that when spermatic vessels are subject to continuous, moderate traction, they will elongate to the extent that will allow the mobilization of the intraabdominal testicle into the scrotum. This is a vessel sparing procedure performed in stages. In the first stage, by laparoscopic approach, the intraabdominal testicle is pulled towards the opposite inguinal ring and attached by a suture to the abdominal wall nearby the opposite inguinal ring. This continuous traction will produce the elongation of the spermatic vessels to a degree that make the scrotal transposition of the testicle possible without cutting the spermatic vessels. The second stage is performed several months later, when the testicle is mobilized in the usual manner, without cutting the spermatic vessels and then repositioned into the scrotum. Sometimes more than 2 stages are required to obtain a satisfactorily length of the spermatic vessels. [3, 33]. The results of this technique are superior to Fowler-Stephen's with an overall success of 84% [33]. An alternative vessel elongation method has recently been reported [34].

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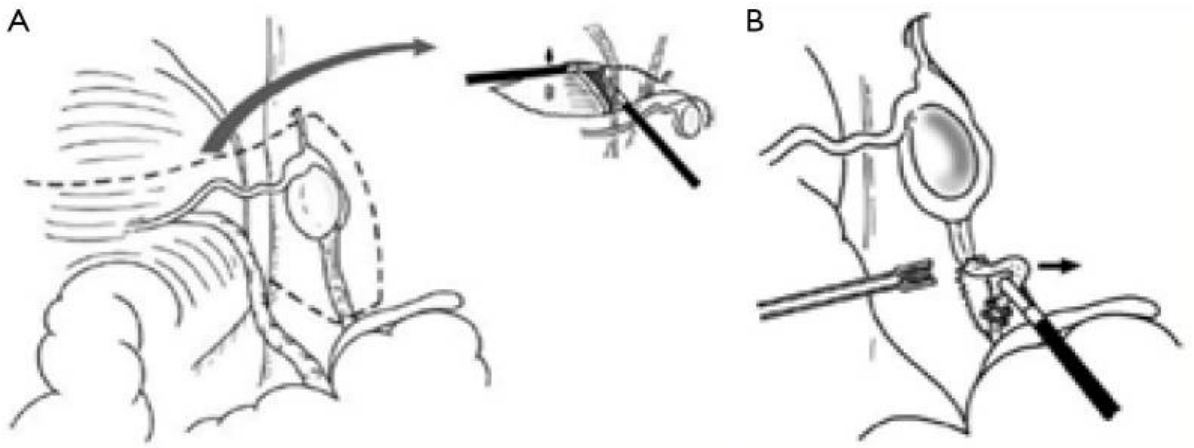

Fig. 1 Fowler-Stephens orchidopexy: A Mobilization of testicle; B Clipping of the testicular vessels
Mark S, Chang, Israel Franco Laparoscopic Fowler-Stephens orchidopexy: the Westchester Medical Center experience, J Endourol, 2008, Jun

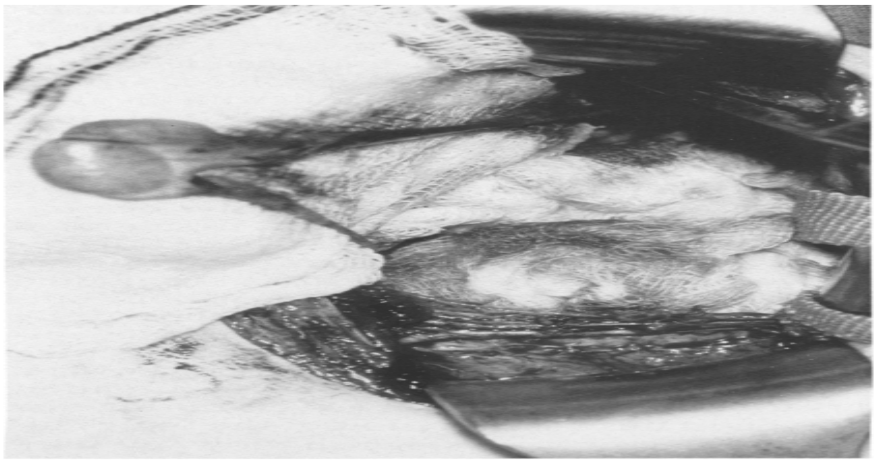

Fig. 2. Microvascular orchidopexy: testicle fully mobilized on short vascular leash and vas
A.Bianchi Management of the impalpable testicle. Pediatr Surg Int(1990) 5: 48-53

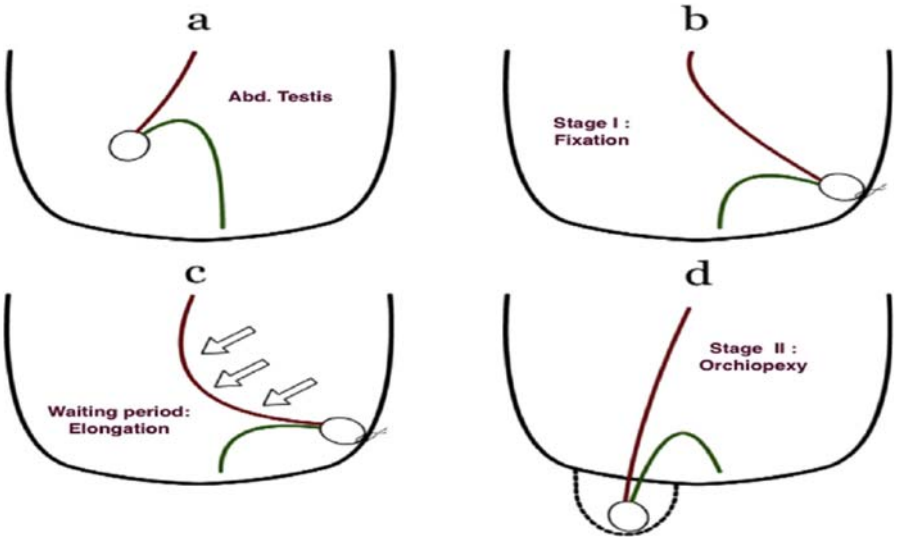

Fig.3. Mechanism of testicular vessels elongation in the Shehata technique
Shehata SM, et al. Staged laparoscopic traction – orchidopexy for intraabdominal testicle (Shehata technique). J Pediatr Surg, 2016

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Complications of treatment

Temporary side-effects of hormonal treatment have been observed, including growth of the penis, pubic hair, pain in the groin and the injection site and also erection pain. Most importantly, it has been demonstrated that treatment with HCG is followed by an increase in germ cell apoptosis, which in turn is associated with smaller testicle volume [35, 36].

Surgical complications are usually rare, with testicular atrophy being the most serious. This effect appears as a result of injury to the sperm vessels during surgery, the spermatic cord tension, iatrogenic torsion and intentional ligation of the vessels as an integral part of F-S orchidopexy. Rare complications include testicular ascent, wound infection, dehiscence and hematoma [4, 11].

Summary

Approximately 20% of UDTs are non-palpable, and they may be undescended or absent. If a testicle is examined under anesthesia and is still non-palpable, diagnostic laparoscopy should be used to identify its location, size and structure. An orchidopexy can be done by laparoscopy or through an inguinal incision [1, 2, 16].

There is good evidence for early placement of UDT in the scrotal position to prevent potential impairment of fertility and reduce the risk of testicular malignancy. No consensus exists on the various forms of hormonal treatment and usually is not recommended [16].

Current recommendation for surgical intervention is any time after 6 months of age if a testicle remains undescended. MacKinnon showed that orchidopexy if done before 2 years, the predicted fertility is around 87% whereas if delayed up to puberty, chances of fertility fall to 14%. Further proof that orchidopexy at earlier age improves fertility is shown in animal conducted studies. Post-orchidopexy, the risk of infertility, is 78%–100% in bilateral and 33% in unilateral orchidopexy [37, 38].

With regards to the surgical technique, there are multiple opinions of the results after laparoscopic orchidopexy; Horasanli et al reported a success rate for the single-stage F-S operation up to 87% and Xinhui et al reported it up to 100%. Ait Ali Slimane et al found that the single-stage F-S technique had a lower failure rate of surgery and a lower testicular atrophy rate than the two-stage F-S. Docimo reported that the success rate of single-stage F-S was 66%, while that the two-stage F-S was 76%. Chang et al and Robertson et al reported that the efficacy of the two-stage F-S was better than of the single-stage F-S, with a success rate up to 90% [38]. Elsherbendy et al found that the staged laparoscopic traction orchidopexy (Shehata technique) is a suitable technique for intra-abdominal testes (within 2 cm of the internal ring), but the results are less satisfactory when applied for higher intra-abdominal testes [40].

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The manuscript must be in English, typed single space, one column on A4 paper, with margins: top – 3 cm, bottom – 2,26 cm, left – 1,5 cm, right – 1,7cm. A 10-point font Times New Roman is required.

The article should be organized in the following format: Title, Names of all authors (first name initial, surname), Names of institutions in which work was done (use the Arabic numerals, superscript), Abstract, Keywords, Text (Introduction, Purpose, Materials and Methods, Results, Discussions and/or Conclusions), References, and first author's correspondence address.