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TABLE OF CONTENTS

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Experimental Results of the Fibrin Clot Use to Accelerate the Regeneration of Damaged Bone in the Rat Lower Jaw

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Abstract

Morphological and radiological methods were used to study regeneration of the damaged bone of rat mandibles after application of platelet-enriched fibrin clot. A bone hole was artificially created, and in the natural course of regeneration, the hole was immediately filled with blood and there a blood clot formed. After one week of healing, separate islands of young bone tissue appeared. After two to three weeks, the opening in the mandible was completely replaced by the young bone tissue. When a similar bone hole was filled with autological fibrin clot, the blood clot did not form. But after one week the entire hole was filed with newly-formed fused bone tissue. By the second week after the use of fibrin clot, the bone hole had further healed and bone callus was formed.

Keywords: Fibrin Clot, Regeneration of Bone, Density of Bone Tissue

1. Introduction

Tissue damage leads to the rupture of blood vessels, which, in turn, is the first step of platelet activation after contact with collagen. Platelets initiate the formation of thrombus through the activation of the coagulation system. After the formation of thrombin, fibrinogen is transformed into fibrin, and this is the first step of wound healing. The use of fibrin preparation recreates this process and accelerates healing [1,2].

Initially, fibrin preparation was used in dentistry to accelerate hemostasis after tooth extraction, especially with patients with blood clotting problems. It was also used to close defects in the bone tissue in the maxillofacial region [3,4].

Then, fibrin glue was used in lieu of sutures to attach tissue during operations, and to improve the grafting of implants from artificial and synthetic materials [5,6].

Platlet-rich plasma is a modification of the fibrin glue prepared from autologous blood and containing a set of cytokines, which causes the migration and division of all mesenchymal (including chondrocytes and mesenchymal stem cells) and epithelial cells, and stimulates the synthesis of collagen and the matrix of connective tissue [7,8].

When fibrin degrades, it causes a migration of osteogenic cells and gingival fibroblasts in vitro and more rapid regeneration of surgical bone defects in the experiment in vivo. Fibrin glues and films can serve as a substrate to support the growth of fibroblasts and their functions. Thus, the adhesive material containing fibrin and fibronectin, their monomers or degradation products, accelerate the healing of periodontal tissue, including bone tissue [9,10].

Compared to the natural course of healing, applying of platelet-enriched fibrin clot (PEFC) results in less pronounced acute and chronic inflammation in damaged tissues. The alteration phase very rapidly replaced by regenerative-reparative processes. Therefore, application of fibrin materials can be used to accelerate tissue regeneration and to facilitate the grafting of implants in experiments and in the clinic [11-13].

It should be noted that along with the positive results of the use of preparations of fibrin, there is evidence of the ineffectiveness of these therapies in dentistry [14-16].

Thus, the literature contains many contradictory and mutually exclusive data on the effectiveness of the use of fibrin preparations in surgery and dentistry. However, these studies do not reflect the use of fibrin for regenerating bone tissue, and in particular, PEFC prepared from autologous blood plasma with platelets.

2. Aim

By using morphological and radiological methods, the natural course of healing and the result of PEFC application to the regeneration of the damaged rat lower jaw were compare in experiment.

3. Material and Methods

The experiment were used 6 month-old Wag male-rats weighing 180-200g. All procedures on the rats were performed under general anesthesia of ether inhalation in a sanitary operating environment in compliance with the "Regulations of the work using experimental animals." At every point of the study, at least 6 rats were used.

It was decided to create holes in bone tissue, which has few individual differences (especially blood vessels and nerves), and does not move when muscles are moving. The lower jaw was chosen due to the fact that there is enough strength and width of the bone combined with ease of access. In addition, the rats cannot prematurely tear out their stitches.

Preparation of PEFC: Several rats of the same breed were decapitated, and 2-7 ml of blood was collected in sterile glass tubes. This blood was centrifuged at 2800 rpm for 12 minutes [11,13]. Then the upper part (platelet-rich fibrin clot or fibrin clot with platelet) was placed in sterile Petri dishes and maintained for several hours in an incubator at 37°C until use. Then, immediately before use, sterile scissors were used to cut the PEFC fragments to the correct sizes.

Creation of the Bone Defect and PEFC Application in the Experiment: Under general inhalant ether anesthesia, in a clean operating room, while respecting the rules of asepsis and antisepsis, after treating the skin with 70% alcohol, a skin incision was made using a scalpel. The incision was 1.5-2 cm along the bottom edge of the mandible. Retractors were used to detach the masticatory muscles and expose the lower surface of the lower jawbone. A dental drill was used at a specific manner (same size, even edges, depth control, the same rotational speed and, consequently, heating of tissues and the possibility of cooling) to create a 2 mm in diameter round hole through the bone in region of mandibular angle, the hole did not connect with the oral cavity. In the control group of rats (natural healing), the bone defect was covered with masticatory muscle and then simple running sutures were used on the skin, and it was treated with alcohol. In the other group, forceps were used to fill the holes with PEFC. The size of the PEFC was slightly larger than the holes. After packing the bones with PEFC, the bone defects were also covered with the masticatory muscle, the skin was sutured with continuous sutures, and alcohol was applied to the wound. All implant materials were sterile.

Animals were withdrawn from the experiment after 1, 2, 3, 4 and 5 weeks after surgery. The bone tissue with defects in the mandible was studied.

Fragments of the mandible were preserved in a 4% paraformaldehyde on biphosphate buffer (pH 7.4) for at least 24 hours. After preservation, the skin, subcutaneous tissue and chewing muscles were removed. The fragments of mandibles were decalcified in solution "Biodek R" (Bio Optica Milano, Italy) for 24 hours, dehydrated in a gradien of ethanol, lightened in xylene, and embedded in paraffin. Sections of 5-7 microns thick were stained with hematoxylin and eosin, and studied under a light microscope Axioimager M1 (Carl Zeiss, Germany) with a magnification of up to 1200 times.

Radiological studies were performed to observe the reparative processes in the mandibles of experimental animals at various healing intervals (**Figures 1** and **2**). The tissue density was estimated in the hole itself, and in the contralateral part of the mandible.

Statistical analysis was performed using applied statistical program of MS Excel 7.0 (Microsoft, USA). The arithmetic mean and standard deviation were determined, the differentiation between means was considered significant at $p \leq 0.05$, used the Student's criterion.

4. Results

At 1 week after injury to the bones of the rat lower jaw with natural recovery, it was found that the hole was partially filled with blood and the hole contained some fragments of connective tissue and granulation (**Figure 3**). This marked the beginning of bone formation in the defect (formation of separate islands of young bones and cartilage among granulation) (**Figure 3**).

After 2 weeks the hole was completely closed by the young bone tissue with a large number of blood vessels on the edge of the defect. Cartilage tissue was also present among the newly formed bone structures.

At 3 weeks the hole was completely closed by the newly formed bone tissue. The only evidence that the defect existed were the remaining large vessels and randomly located bone trabeculae (bone callus). At this point, a fully formed cavity with bone marrow appeared.

After 4 and 5 weeks, in most cases, the only remaining trace of the operation was bone callus (**Figure 4**).

One week after injury to the bone with use of PEFC, the hole was completely filled with fused islets of newly formed bone (**Figure 5**). In other words, after the application of PEFC, bone regeneration resulted in the complete filling of the artificial hole after one week.

In most cases, after two weeks, the injury to the bone was filled, regardless of whether PEFC was applied. The holes were closed with newly-formed bone tissue with a large number of blood vessels at the periphery of the defect and cartilage tissue in the center.

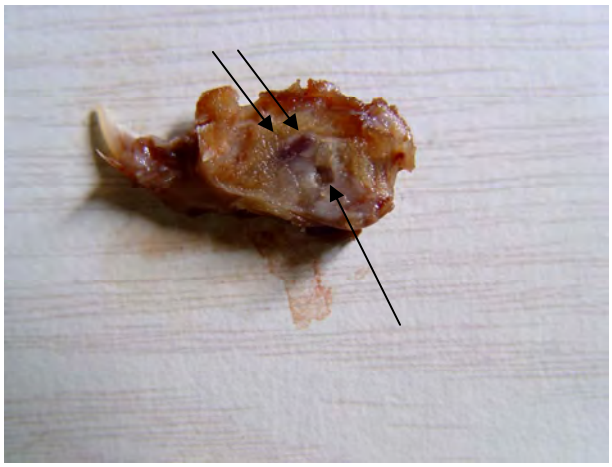

Figure 1. Macroscopic appearance of rat mandible with remote masticatory muscles 1 week after injury and natural regeneration. There is no evidence of purulent inflammatory process. An arrow indicates the artificially created opening filled with blood clot. The two arrows—the root of the central incisor.

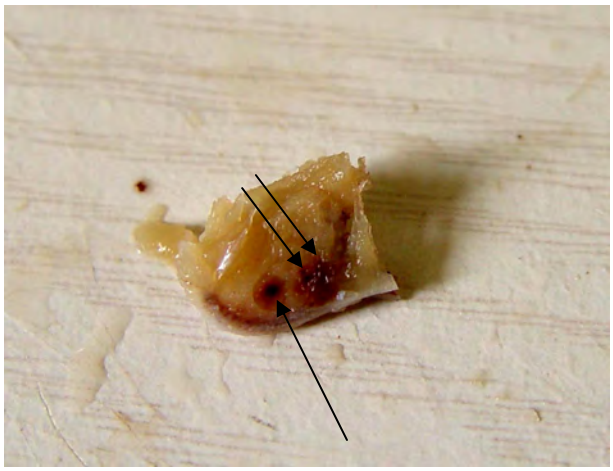

Figure 2. Macroscopic fragment of mandible of rat 1 week after a bone defect is then filled with PEFC. The artificially created hole has no macroscopic signs of inflammation, is filled, and is located at the level of the surrounding tissues. An arrow indicates the artificially created hole filled with PEFC. The two arrows—the root of the central incisor.

After 3, 4 and 5 weeks of healing, the hole was completely covered by newly formed bone tissue with randomly arranged bone trabeculae formed callus and cavities with bone marrow (**Figure 6**). This was true in the mandibles that healed naturally and the ones with PEFC applied.

After statistically controlling for data of densitometry of the rats' mandibles' bone defect regeneration in natural healing and after applying PEFC, no significant differences in the density of tissue between the compared groups of animals was found at each point of the study. However, the density of tissue in the natural reparative processes was statistically significantly different from healthy bone on the contralateral side during the first 3 weeks. In contrast, the density of tissue in the PEFC assisted process was statistically significantly different from healthy bone on the contralateral side only during the first and second weeks. (**Figures 7** and **8**) (**Table 1**). That is, the bone tissue with PEFC applied became dense faster than with natural healing.

In addition, it should be noted that all periods of observation the density of tissue in the affected area after applying PEFC was slightly higher than during the natural course of repair (**Figures 7** and **8**), although this difference was not significant. The maximum difference in tissue density was noted from 2 to 4 weeks. By week 5, the differences were smoothed out somewhat (**Table 1**).

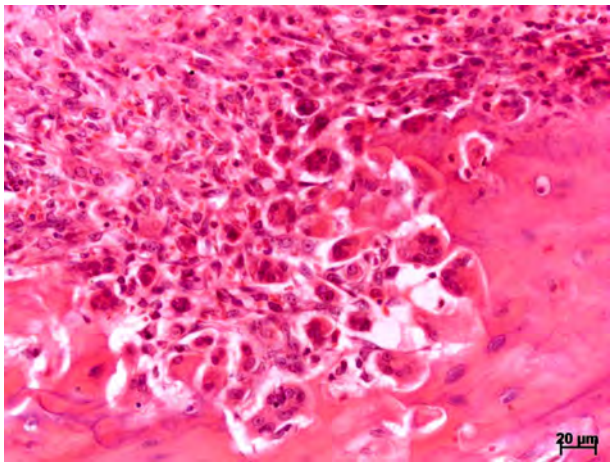

Figure 3. The formation of bone structures at the periphery of the damaged part of the mandible in natural healing 1 week after surgery. Hematoxylin and eosin.

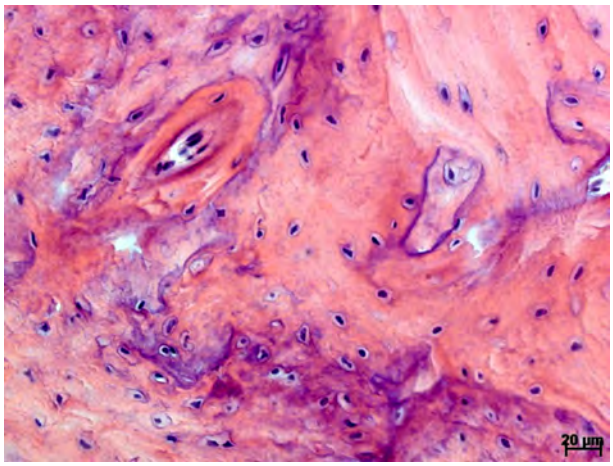

Figure 4. Bone defect of the mandible with self-regeneration 4 weeks after surgery. Bone tissue struts in the callus are unstructured. Hematoxylin and eosin.

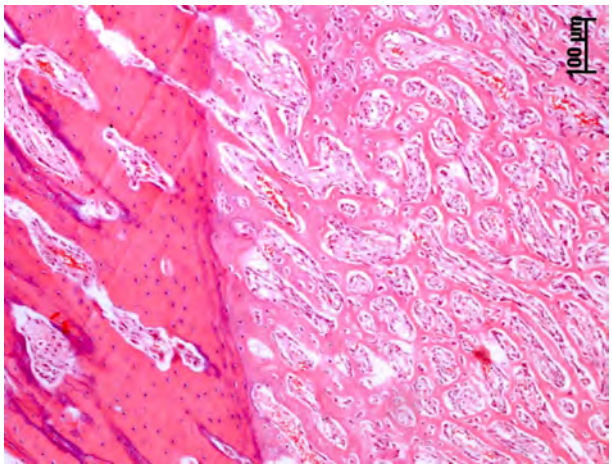

Figure 5. Healing area of damaged bone of the mandible 1 week after surgery using PEFC. Bone defect filled with fused islands of the young bone tissue with a large number of vessels. Hematoxylin and eosin.

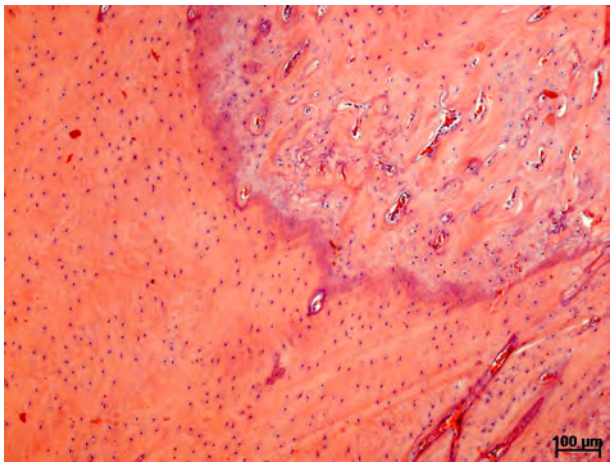

Figure 6. Structures of callus on the spot of the holes in the bones of the mandible 4 weeks after the operation and use PEFC. Hematoxylin and eosin.

5. Discussions

In the experiment, when the bone tissue was damaged, an acute inflammation of the tissues occurred. This process occurs in response to direct tissue damage as a result of surgical intervention. Over time, an inflammatory reaction due to the operation subsides, and the process of restoration of damaged tissues begins.

During the natural healing process, when the mandibles were damaged, the holes immediately filled with blood, and a clot formed with a large number of red blood cells. Gradually, this clot was dissolved by phagocytes (first neutrophils, then macrophages), and was gradually replaced by migrating osteogenic cells. Due to the functioning of osteoblasts, the young bone tissue began to take shape from the edges of the defect. These islands of young bone become wider and merge. In almost all cases, 2-3 weeks in rats, a complete bone regeneration took place in the artificially created defects. It should be noted that the morphological data on bone regeneration by the dates specified were confirmed by the results of densitometry.

Fibrin in tissue, according to published data, reduces the severity of the inflammatory process [11-13] and limits the spread of infection [17,18]. That is, the introduction of PEFC in the cavity of the wound, apparently, can protect the surrounding tissues from the dissemination of microorganisms, and from excessive exposure of lysosomal enzymes of phagocytes. This limits tissue destruction and, therefore, earlier starting the regenerative processes in tissues, there is less antigen and detritus, and a more rapid cleansing of the wound.

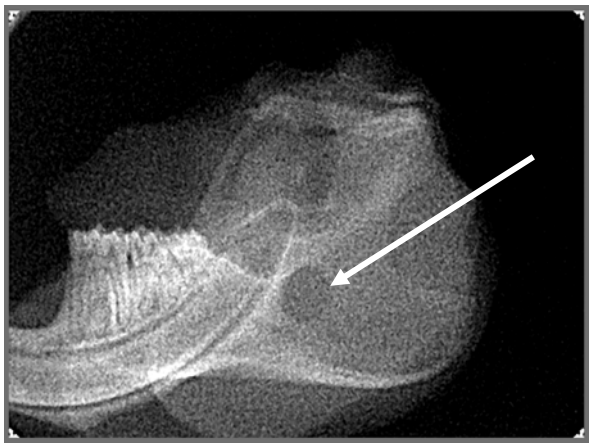

Figure 7. Bone defect of the mandible during the natural course of recovery 3 weeks after the operation, according to radiological study, artificially created hole (indicated by arrow) is preserved.

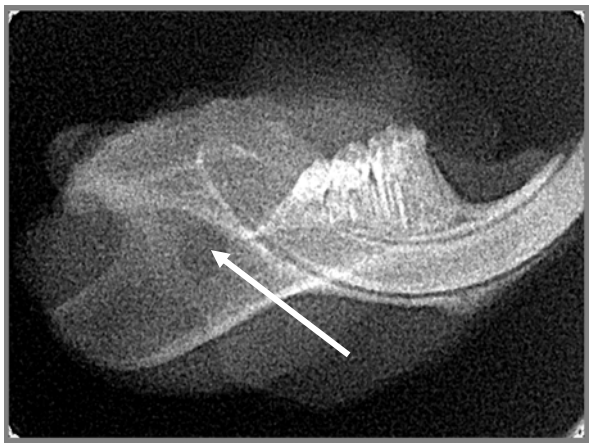

Figure 8. Artificially created opening in the bones of the lower jaw (indicated by arrows) is retained according radiological study 3 weeks after surgery using PEFC. The density of tissue in the defect after the application PEFC above.

Table 1. The bone density in defect of the lower jaw in comparison with surrounding intact tissues (S ± σ).

Time after operation	Regeneration Process		Difference in Density (Fibrin-Control) in Defect
	Natural Healing	After Using PEFC	
1 Week	0.892 ± 0.053*	0.913 ± 0.017*	0.021 ± 0.05
2 Weeks	0.922 ± 0.038*	0.953 ± 0.021*	0.031 ± 0.033
3 Weeks	0.914 ± 0.033*	0.949 ± 0.036	0.035 ± 0.051
4 Weeks	0.912 ± 0.059	0.942 ± 0.048	0.03 ± 0.043
5 Weeks	0.913 ± 0.064	0.924 ± 0.063	0.011 ± 0.008

Note: *data, significantly different from the intact bone on the contralateral side ($p \leq 0.05$).

In addition, the fibrin clot acts as matrix capturing migrating leukocytes (neutrophils), endotheliocytes and fibroblasts [7-10]. Thrombospondin-1 from platelets stimulates tubulogenez (initial stage of angiogenesis) by endothelial cells [10].

Migrating through fibrin [7,8], neutrophils more rapidly reach all sections of the wounds, even wounds covered with layers of pus and detritus and, thus, tissues are more rapidly cleared from the antigenic substances (microorganisms and the same detritus). In addition, when moving through fibrin clot neutrophils partially dilute it with its own enzymes, so even dense fibrin clots become less dense, and similar to a net.

Fibroblasts, located in the fibrin network [7,8,10], begin the synthesis of collagen, not only from the bottom of the wound, but also from its cavity, thus the scar tissue forms more rapidly.

It should be noted that the fibrin not only facilitates the migration of fibroblasts, but it also accelerates the synthesis of connective tissue [5,7,8,11-13,20].

Fibrin also stimulates the migration of endotheliocytes [7-9], and therefore the process of angiogenesis begins more quickly [19]. The newly formed blood vessels are located not only in the granulations on the wound bottom, but also in the fibrin net. The more rapid growth of blood vessels, in turn, facilitates migration of leukocytes from the blood vessels and synthesis of components of connective tissue.

When the bone injuries were filled with PEFC, there was no need to wait for the blood clot will be destroyed and the red blood cells will be eliminated via through phagocytosis. After one week in most cases, the bone defect was already filled with fused islets of newly-formed bone tissue. That is, when PEFC was applied, the artifical defect was almost completely filled after one week.

By the second week after using PEFC there was a further gradual filling of newly formed bone tissue in the defect with a large number of blood vessels in the periphery. By third week the formation of bone callus completely covered the opening of the bone, also red bone marrow was observed in the defect. These changes continued to occur to varying degrees in subsequent periods of observation.

Fibrin is present in both natural healing and in the PEFC enhanced process. Fibrin facilitates the migration of neutrophils, endothelial cells, macrophages, osteoblasts and other cellular elements. However, what distinguishes natural healing is the large number of red blood cells in the blood clot. The presences of these cells in the fibrin net impede the migration of the aforementioned cellular elements. In addition, some potential phagocytes will be spent not only on the intake of detritus, but also on phagocytosis of red blood cells from a clot.

Thus, on the basis of the foregoing, we conclude that when PEFC is applied, the start of the repair processes is more intense than in the spontaneous healing. The hole in the bone quickly filled with islands of bone tissue, which merged earlier than in the natural process. Apparently, the formation of the young bones begins immediately after the operation without the need to spend time for the process of lysis and the removal of red blood cells from the clot.

Since application of PEFC causes a more intense regeneration of damaged bone, it appears to be advisable to use PEFC to accelerate the reparative processes of bone tissue in dentistry, surgery and traumatology.

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6. Conclusions

In the natural course of regeneration, when the mandibles of rats were damaged, the defect was filled with a blood clot with a large number of red blood cells. After 1 week of healing, the damaged area contained separate islands of young bone tissue, as well as fragments of the blood clot and granulation. After 2-3 weeks of healing, the opening in the bone of the lower jaw was completely replaced by the young bone tissue.

When the side of damaged rat mandibles was filled with PEFC, no blood clot was formed. After one week, the entire bone defect was filled with newly formed islets fused bone. By the second week after using PEFC there was a further substitution of the defect with bone tissue and the formation of bone callus.

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The Open Packing of the Lesser Sac Technique in Infected Severe Acute Pancreatitis

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Abstract

Aim: The goal of this study is to evaluate the open packing of the lesser sac (OPLS) in treatment of infected severe acute pancreatitis **Methodology:** The study was based on 98 cases in which this technique was applied during the period between 1994-2007, in two departments of surgery (Clinical Hospital CF 2 and Clinical Hospital „Sf. Maria" Bucharest). The technique was applied based on the therapeutically protocol previously established beginning with 2000. The OPLS technique was analyzed relatively to: timing of surgery, the localization of the infected necrosis or abscesses, growing germs on the cultures, antibiotics received, executed primarily or at re-intervention, the number of debridement, hospitalization, morbidity and mortality. The information was statistically processed using SPSS test version 17 for Windows. **Results:** The OPLS technique improved the control of the local sepsis, in the retrospective/prospective study in 83.7%. Mortality was 16.3% (16/98), with a global mortality of 26.3% (75/285) and a postoperative mortality of 29.5% (66/224). **Conclusions:** Considering the fact that the intensive care techniques are approximately the same in the last 15 years, we thought that this improvement in the survival rate may be due to the application of OPLS in cases with indication and optimal timing for surgery.

Keywords: Open Packing of the Lesser Sac (OPLS), Severe Acute Pancreatitis (SAP), Infected Necrosis, Pancreatic Abscess and Necrosectomy

1. Introduction

Surgical intervention in infected SAP has as its main aim to counteract the effects of local septic complications [1]. There are still divergent opinions regarding surgical techniques adopted to be effective in treating pancreatic and extrapancreatic infections [2]. The decision of using a certain surgical technique after necrosectomy is individual and depends on the evolution of the disease, the timing of surgery, the extension of the pancreatic or extrapancreatic necrosis and on the surgeon's experience [3, 4]. The usage of semi-open abdomen as in infected SAP therapy was first described in 1894 by Korte [5,6]. More recently, Bradley [7] has shown decreased mortality by using semi-open abdomen and subsequent re-exploration.

2. Material and Method

Due to unsatisfactory results arising from the retrospective analysis (1994-1999) after using pancreatic resection or a necrosectomy followed by multiple peritoneal drainages and closure of the abdominal wall, we adopted the therapeutic protocol based on aggressive intensive care, necrosectomy and semi-open abdomen technique, respectively the open packing of the lesser sac (OPLS) (prospective approach 2000-2007). The analysis includes 947 cases with acute pancreatitis admitted between 1994-2007, in the 2 clinics (Clinical Hospital, Santa Maria" and Clinical Hospital CF 2 Bucharest) of which 285 cases with severe form (152 cases of male and 133 female, the average age of 53.2 years). Of these 224 (78.6%) cases have undergone surgical intervention and

61 (21.4%) cases were treated conservatively. In data processing we used information provided by the admission on the evaluation sheet of the patient with acute pancreatitis within 72 hours (prospective approach) and information from the file of the patient during hospitalization: general information (age, sex, history, associated diseases, mode of onset, body mass index – BMI > 30 kg/m^2), clinical data, laboratory data, severity scores (Glasgow to admission and to 48 hours, modified APACHE II score for acute pancreatitis), etiology of pancreatitis, Multiple Organs Dysfunction Syndrome (MODS), results of microbiological cultures performed before surgery (CT-FNA), during surgery and after surgery, imaging investigations (ultrasound, pulmonary radiography, computerized tomography) antibiotherapy (prophylactic and curative), duration of hospitalization, duration of hospitalization in ICU, timing of surgery, data obtained during surgery (extension of the pancreatic and extrapancreatic necrosis, cholecystitis, biliary pathways, ascites, associated visceral lesions), conservative and surgical treatment applied, outcomes (healing, complications, recurrence, re-interventions), mortality and necropsy data.

The retrospective/prospective study was analyzed by etiological forms with specific therapeutic management, and timing of surgery was analyzed with the benchmark of 21 day according to the studies of Fernández del Castillo [8] and recommendations of the International Association of the Pancreatology (immediate emergency < 72 hours, within 3 weeks or after 3 weeks) [9]. In 98 cases we have adopted the OPLS technique without forcing its application where it wasn't indicated, according to the intra operative findings. We found that the combination of pre and post operative measures with this technique (OPLS) can significantly reduce mortality in this disease.

The OPLS technique was analyzed in several ways: timing of surgery, location of infected necrosis or abscesses, microbiological cultures, antibiotics treatment, if it was done at first surgical intervention or at the reintervention, number of debridement's, duration of hospitalization, duration of hospitalization in ICU, morbidity at short and long time and quality of life after surgical intervention. All elements have outlined the value of the OPLS technique in surgical management of the infected SAP.

3. Outcomes

The surgical technique we applied was the classical one with several improvements. Firstly, the timing of intervention is delayed until the occurrence of the clearly defined infected necrosis [3,10,11] (**Figure 1**).

Secondly, we limited the propagation of infection in submesocolic peritoneal cavity by creating this omental laparostomy with suturing the cutting edges of the gastrocolic ligament to the supra-umbilical anterior parietal peritoneum, near to the laparotomy, achieving the, marsupialisation" of the lesser sac [5,12]. With this maneuver we protect submesocolic region by creating an "omental wall". Another major advantage of our approach was the subsequent necrosectomy, daily during the first week, which was accompanied by the change of dressings and packing gauzes. In sterile conditions, in operation room under epidural anesthesia, the patients are submitted to local washing with soft disinfectants (hydrogen peroxide, bethadine, chlorhexidine), and redebridement under visual control. At this time we perform the cleaning of the drainage tubes probably clogged by the organic debris, sampling for microbiological exams of the necrotic debris extracted, fluid secretion of the wounds, possibly secretions occurring at the drainage tubes when they had suppurative aspect, followed by repositioning of the packing gauzes (Miculicz type) in the omental laparostomy (**Figure 2**).

"Targeted" antibiotherapy and antifungal medication was initiated according to the microbiological results. Simultaneously we carefully perform haemostasis in the areas of necrosectomy, even with the harmonic scalpel if the situation required it. In order to avoid the formation of gastric or colic fistulas we imbued the adjacent packing gauze of these areas with sterile paraffin oil. In this

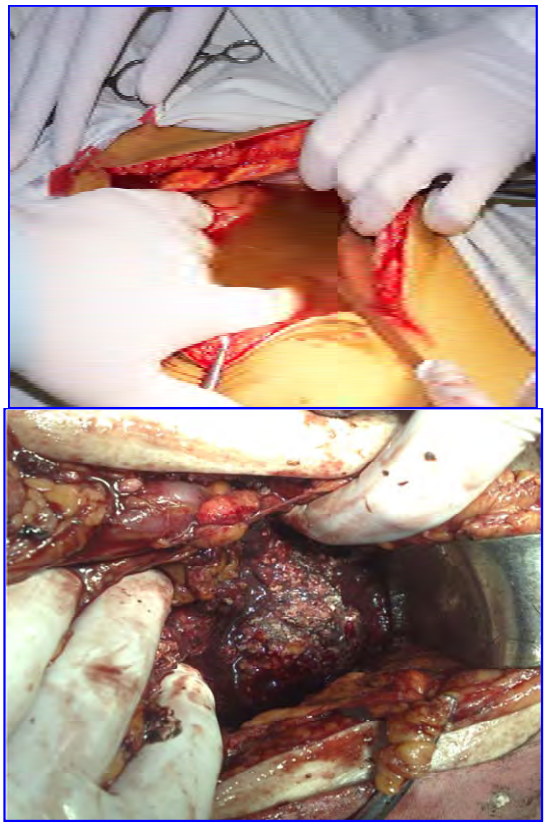

Figure 1. Intraoperative findings: infected necrosis with suppurative pancreatic ascites.

way, the patient that undergoes surgical intervention was evaluated at least once a day by the operative surgeon.

It is important that the patient is observed by the same surgeon because in this way he will be "familiar" with systemic and local particularities of the case and take the right decisions regarding the necessity of the necrosectomy in the remaining areas of necrosis after surgery and will be able to identify early those arising in the evolution. Sometimes, areas of evolving deep necrosis cannot be identified during the changing of the packing gauzes but they are suggested by the patient's clinical decline. In these situations we used the CT scan to identify areas of evolving necrosis exploring hidden to the laparostomy and which require a formal re-exploration. After a period of 7 to 10 days (after granulation in this area) patients are examined at laparostomy, using soft sedation, in the ICU or at room dressings, under strict aseptic conditions.

Only non-viable tissues are removed using digital debridement or blunt instruments, sometimes necrotic material was removed when changing the packing gauzes by using washing fluids (**Figure 3**).

The diagnosis of microbiological status of pancreatic and extrapancreatic necrosis was performed in the basis of clinical pathological correlations using macroscopic findings and results of bacterial cultures.

Microorganisms responsible for secondary infection of pancreatic and extrapancreatic necrosis of this study are listed in **Table 1**.

It is known that the success of any aggressive or radical approach, of a disease such as acute severe infected pancreatitis, depends largely on the degree of cooperation between the surgeon, anesthesiologist, radiologist and microbiologist [11]. At the opening of the peritoneal cavity, this is subjected to exogenous contamination. It takes place a double contamination of the pancreatic and extrapancreatic necrosis by the secondary nosocomial micro-organisms with low sensitivity to antibiotics. Septicemia caused by exogenous or endogenous flora is the most common cause of mortality in severe acute pancreatitis [1,9].

The accurate microbiological diagnosis with the evidence of the sensitivity of the microbial flora, targeted antibiotherapy and a proper hygiene strategy represent the most important requirements of the therapeutic management in the cases of the OPLS technique. At the level of the laparostomy, peritoneal fluid, blood and purulent secretions are the most significant concerning the results from the microbiological point of view.

The hemogram, and the cultures for aerobic and anaerobic flora with antibiogram must be made attentively in both situation: nonsurgical patients (possible "gates of entry" for infection of the necrosis) and at the operated patients (laparostomy).

In the retrospective/prospective study the OPLS technique was performed in 11 cases at reinterventions (11.2%). The OPLS technique applied in these cases is more laborious and predisposes to an increased risk of bleeding or pancreatic tissue injury, spleen or adjacent cavitare organs. The main operative indication in these cases is secondary infected necrosis, after unexpected emergency laparotomy after 14 days of evolution of the disease or when the surgeon feels that he had a "total control" over pancreatic and extrapancreatic necrosis at

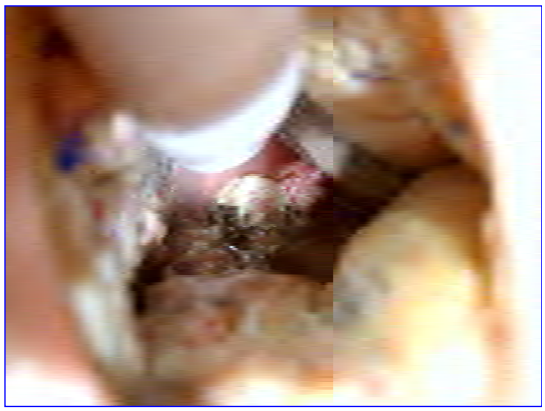

Figure 2. View of infected evolutive necrosis within 7 days after surgery. Notice small necrosis with trend of detachment from viable tissue. Final appearance after dressing (box).

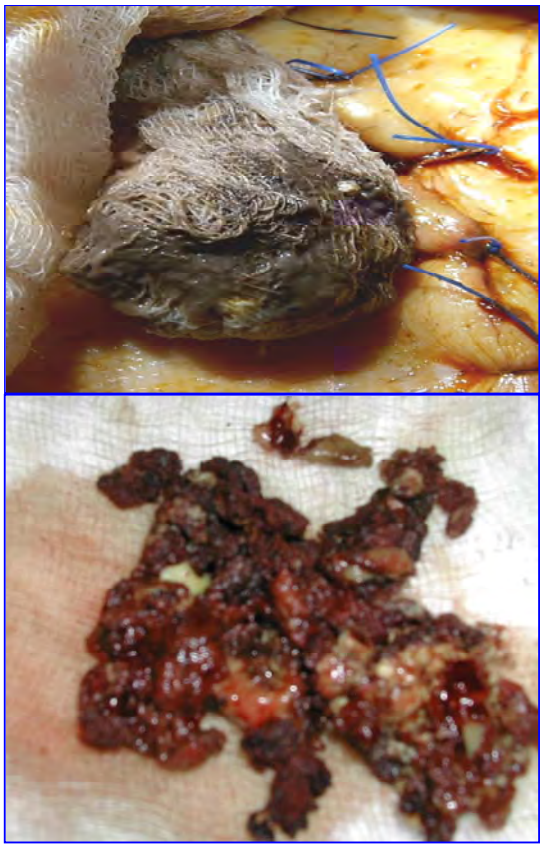

Figure 3. View of the extracted necrosis to re-explorations trough the lesser sac laparostomy.

Table 1. Bacteriology of secondary infected necrosis, during treatment with OPLS technique.

Microorganism	N = 62
Escherichia coli	15
Klebsiella pneumoniae	7
Staphilococus aureus	8
Pseudomonas aeruginosa	5
Enterococcus faecalis	3
Candida albicans	8
Polimicrobian infections	16

the first intervention and he closed the abdomen with simple drainage.

This secondary infection of the pancreatic and extrapancreatic necrosis is the determining factor of recurrence of MODS and, subsequently, high risk of death, even if not all forms of secondary infection present the same risk. Infected acute pancreatic pseudocyst and pancreatic abscess have had a low rate of mortality comparative with infected diffuse necrosis [1,4].

Consequently, in the effort to improve survival rate in severe acute pancreatitis special attention should be given to the therapeutic management of these secondary infections, especially on the secondary infected necrosis.

Following our experience we believe that the OPLS technique is a good alternative in terms of surgical technique to apply in these complications difficult to treat. In order to prevent digestive fistulas of the organs around the laparostomy (stomach, colon, duodenum) we used protection foil, from plastic material, non adherent, which allowed the leak of the secretion to the exterior. We use these foils 5-6 days after surgical intervention when the wounds begin to granulate to prevent suppurative complications of the abdominal wall. Near the limits of the laparostomy we used only non absorbable monofilament threads (USP 0), to prevent eviscerations especially for the patient's witch require mechanical ventilation after surgery.

In order to change the dressings and packing gauzes, epidural or intravenous anesthesia is required a certain period (usually 12 to 14 days). After the granulation of the retroperitoneal space and repeated sterile cultures, the abdominal wall may be secondary closed if the abdominal wall did not retracted and allow this maneuver [5,13, 14]. We preferred to let the wound to heal *per secundam* for better survey to avoid encystations of any collection or these one may spontaneously evacuate trough the laparostomy.

Also, the occurrence of the pancreatic fistulae allows initial exteriorization at this level, therapeutic measures will be adopted as necessary depending on the flow and persistence of the fistula. In most cases (n = 77; 78.6%) the abdominal wall closed secondarily did not required reintervention for the occurrence of the eventration after 6-8 months (**Figure 4**).

Consecutively of applying of this technique (n = 98;43.75% with n = 87 at first intention and n = 11 at reintervention) the mortality recorded in this group was 16.3% (16/98) better than a overall mortality 26.3% (75/285) or that of the patients operated using other surgical procedures 52.4% (66/126). Causes of postoperative morbidity and mortality are shown in **Table 2**.

Only 2 cases died because of recurrent sepsis. Hepatic insufficiency has been associated with other causes of death. 1 case had septicemia with *Pseudomonas* resistant to antibiotherapy and another by massive digestive bleeding due to infection with *Candida* without response to fluconasol systemically administered. In other cases, death occurred after the signs of sepsis had been eradicated.

Under these conditions of the severity of disease, the morbidity was quite high. External pancreatic fistulas (n = 17) and 1 case with incomplete duodenal obstruction have evolved over time, 2 of them requiring surgical treatment and the patient with duodenal obstruction was submitted to exclusion gastric resection 6 months after.

Medical complications (exocrine and endocrine dysfunction) in fact reflect the percentage of the pancreatic tissue lost infective during the infectious process. Only

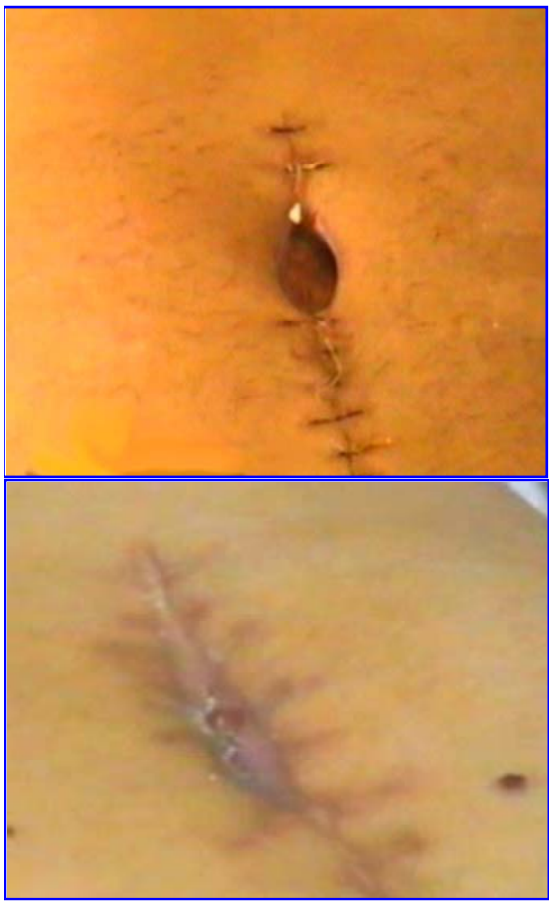

Figure 4. *Per secundam healing* of the lesser sac.

17 cases had eventrations and required surgery to cure it with prosthetic mesh after 6-8 months. Chronic pancreatitis occurred in 28 cases (28.6%), documented clinically by persistent pain and recurrent diarrhea and calcification in the pancreatic area at CT scan, microlithiasis of the Wirsung and typical aspects to the ERCP or MRI colangiopancreatography examination.

The weight of the necrotic tissue removed in the operating room and subsequent necrosectomies was measured only at the last 15 patients (**Table 3**). The average weight of the necrotic tissue removed intra operatively was 200 ± 80g, with the remaining quantities of necrotic tissue occurred in evolution after surgery being removed from further re-exploration through laparostomy. The possibility of removal of infected necrotic tissue occurred in the evolution is the biggest advantage of the OPLS technique compared with the closed abdomen techniques.

The average hospitalization of the patients undergoing OPLS was 54 days (31-82) to discharge with duration of hospitalization in ICU, averaging 22 days (18-27). The period of hospitalization does not differ essentially comparative with those studies that refer to the use of closed techniques, and is closer to those that refer to the use of technique of closed lavage of the lesser sac. The average number of the re-explorations was 11 (5-16) (**Table 4**).

The necrosis was strictly limited to the pancreas to a small percentage of cases (in prospective study n = 28; 15.6%). In the retrospective study only 9 cases (12.5%) had infected necrosis strictly limited to the gland. Most patients presented extensive extrapancreatic necrosis to the lesser sac region, in the subphrenic left region, in the root mesentery, retrocolic or in pelvic region (in prospective study n = 152; 84.4%).

Using the numerical criteria of extrapancreatic necrosis we divided the study (retrospective and prospective) into two subgroups: cases with maximum 2 areas of the extrapancreatic necrosis and cases with more than three areas of the extrapancreatic necrosis. In the retrospective study, the abdomen was closed in most cases and multiply drained (75/90; 83.3%), only 13 cases OPLS technique was applied at the first intervention and in 2 cases at reintervention.

In the prospective study, the abdomen remained semi-open at the first intervention in 61.9% of the cases (n = 83/134) and in 9 cases of reintervention, with an evident increase in the group with more than 3 areas of extrapancreatic necrosis from 29.5 to 41.5% (**Table 5**).

Concerning the complete necrosis of the pancreas the percentage in the retrospective study (n = 7; 6.7%) was higher comparative with the prospective study (n = 5; 3.7%), but increases the frequency of using the OPLS technique (**Table 6**). This extension of the necrosis is not statistically significant in terms of surgical therapy ($p = 0.9$) but only in terms of frequency of infected necrosis ($p < 0.05$).

Table 2. The results in infected pancreatic necrosis after applied the OPLS technique.

MORTALITY	n = 16/98; 16.3%
Recurrent sepsis	n = 2; 2%
Hepatic insufficiency	n = 14; 14.3%
Myocardial infarction	n = 1; 1%
Pulmonary embolism	n = 1; 1%
Hemorrhages	n = 1; 1%
MORBIDITY (local postoperative complications)	
External pancreatic fistula	n = 17; 17.4%
Eventrations	n = 17; 17.4%
Intestinal occlusion	n = 2; 2%
Hemorrhages from major vessels	n = 4; 4.1%
Enteral fistula	n = 2; 2%
Gastric fistula	n = 2; 2%
Colic fistula	n = 4; 4.1%
MORBIDITY (systemic postoperative complications)	
Pneumonia	n = 6; 6.1%
Renal insufficiency	n = 17; 17.35%

Table 3. The weight of the necrotic pancreatic and extrapancreatic tissue removed at surgery and subsequent re-explorations.

	n = *	**Weight** (g)	**Weight range**
Operative exploration	15	200 ± 50	50-250
First re-exploration	15	70 ± 30	30-100
A second re-exploration	15	60 ± 30	20-90
A third re-exploration	15	40 ± 20	20-60
The fourth re-exploration	15	30 ± 15	7-45
The fifth re-exploration	15	20 ± 12	0-32
Sixth re-exploration	13	15 ± 7	0-23

Table 4. OPLS – Postoperative re-debridement.

Number	1-4	5-8	9-13	14-15	> 15
Cases (n = 98)	0	19	67	12	1

Table 5. The incidence of areas of the extrapancreatic necrosis in retrospective/prospective study.

Documented cases n = 213	**Extrapancreatic necrotic areas**	**Cases**	**%**
Retrospective study	0-2	43/61	70.5
	3-5	18/61	**29.5**
Prospective study	0-2	89/152	58.5
	3-5	63/152	**41.5**
Closed abdomen	0-2	87/115	75.7
	3-5	28/115	24.3
OPLS	0-2	35/98	35.7
	3-5	63/98	54.3

Table 6. The incidence of partial or total necrosis of the pancreas in retrospective/prospective study.

n = 224 operated cases	Pancreatic necrosis	Cases	%
Retrospective study	Partially	83/90	93.3
	Totally	7/90	**6.7**
Prospective study	Partially	129/134	96.3
	Totally	5/134	**3.7**
Closed abdomen n = 126/224	Partially	120/126	95.2
	Totally	6/126	**4.8**
OPLS n = 98/224	Partially	92/98	93.9
	Totally	6/98	**6.1**

Reinterventions frequency is higher in the retrospective study (3 patients in this group required 3 reinterventions). The deceases in the cases operated occurred in the group with reinterventions in a percentage of 52.9% (45/85) (**Table 7**).

The increased rate of the reintervention is correlated with the extension of the pancreatic and extrapancreatic necrosis: 78.8% (n = 67) in the group with 3 or more areas of necrosis vs. 11.8% (n = 18) in the group with only 2 areas of necrosis (**Table 8**) and 75% (n = 9/12) at patients with complete glandular necrosis vs. 35.8% (n = 76/212) patients with partial glandular necrosis (**Table 9**).

Since 2000 we have embedded the concept of the OPLS technique in the therapeutic protocol of the infected SAP because of the high percentage of the reinterventions. Initially, when we suspected further evolution with extensive infected, evolving necrosis, after intraoperative exploration of the abdomen, the closure of the laparostomy was avoided.

The number of the necrosectomies subsequent of the interventions at patients first treated by OPLS technique is correlated with the extensions of the extrapancreatic necrosis but not with the extension of the organ necrosis. Patients with three or more areas of the extrapancreatic necrosis required frequent redebridement (more than 12), while patients with maximum 2 areas of extrapancreatic necrosis the average of necessary redebridements was 6 (**Table 4**).

This assessment of extrapancreatic necrosis extension shows that this is the best criteria of decision, in such patient, to use or not the OPLS technique.

Analyzing the incidence of the MODS, pre and post surgery and the mortality, we considered, firstly, the number of renal, pulmonary and cardiac dysfunctions. In the group of patients treated with OPLS technique (n = 98) we found preoperative increased incidence of renal, pulmonary and cardiac dysfunction (**Tables 10** and **11**). In the group operated without MODS we recorded 3 deaths (3/224). Patients operated with MODS and who deceased were n = 63 (63/224). Analyzing the postoperative rate of complications on patients to which the OPLS technique was performed and patients to which was performed closed abdomen we found it quite high in both groups.

Comparing the mortality from the point of view of a specific organ dysfunction it can be concluded that at patients with closed abdomen and drainage at first intention the development of postoperative organ dysfunction

Table 7. The incidence of the reinterventions after necrosectomy with closed abdomen in retrospective/prospective study.

Reintervention 85/224	Reintervention					
	1	2	3	4	5	6
Retrospective study (n = 48/90; 53.3%)						
Cases	38	6	3	-	-	1
Deaths	21	4	2			1
Prospective study (n = 37/134; 27.6%)						
Cases	27	7	3	-	-	-
Deaths	11	5	2			

Table 8. The incidence of the reinterventions after necrosectomy with closed abdomen and frequency of the debridements after OPLS technique correlate with the number of the areas of extrapancreatic necrosis in retrospective/prospective study.

Reinterventions 85/224	**Number of the areas of extrapancreatic necrosis**	**Reintervention**				
		n			%	
Retrospective study **Closed abdomen**	0-2	17/48			35.4	
	3-5	31/48			64.6	
		Iterative debridement				
Prospective study **OPLS technique**		1-4	5-8	9-13	14-15	>15
	0-2 (8/37)	0	6	2	-	-
	3-5 (29/37)	0	8	11	9	1

Table 9. The incidence of the reinterventions after necrosectomy with closed abdomen and frequency of the debridement after OPLS technique correlate with the partial or total necrosis of the pancreas in retrospective/prospective study.

Reinterventions 85/224	**Pancreatic necrosis**	**Reintervention**				
		n			%	
Retrospective study **Closed abdomen**	Partially	42/48			87,5	
	Totally	6/48			12,5	
		Iterative debridement				
		1-4	5-8	9-13	14-15	>15
Prospective study **OPLS technique**	Partially (31/37; 83.8%)	0	4	19	8	-
	Totally (6/37; 16.2%)	-	1	2	2	1

is more frequent compared with those on which was practiced the OPLS technique. At patients who survived (in both retrospective and prospective studies) mechanical ventilation was required in the postoperative period in 11 cases, postoperative pain was reduced, intestinal transit was quickly resumed and allowed early mobilization of the patient.

4. Discussions

We emphasize that the technique (OPLS) allowed control of the sepsis in retrospective/prospective study in 83.7% of cases. Mortality recorded was 16.3% (16/98) in comparison with overall mortality of 26.3% (75/285) or mortality registered in group of the surgical patients 29.5% (66/224). Because the therapeutic management in ICU has not been changed radically in the last 10-15 years, we consider that the improvement in survival rate was achieved by applying the OPLS technique at cases with indication and of an optimal timing of surgery.

The main advantage of the OPLS technique is represented by repeated and progressive evacuation under visual control of the subsequent necrosis, infections, and toxic compounds, simultaneously with the intensive support therapy. The combination between this technique with the drainage of the lesser sac, the drainage of the main collections developed in retroperitoneal subphrenic left region or submesocolic region and the drainage of the Douglas, makes the OPLS technique a good surgical option in selected cases, despite the repeated trauma (relative) on tissues at this level.

The principles underlying the OPLS technique are [12, 15,16]: it facilitates the re-exploration of the lesser sac to the next scheduled inspection; allows an effective drainage of intra abdominal sepsis (surprising formation of new collections to be drained); and virtually eliminates the risk of developing abdominal compartment syndrome (ACS) [10,17].

Despite these relatively good results, the probability of failure is not fully eliminated because of some issues, which should be taken into account: the laparostomy provides the advantage of the easy access for drainage and successive redebridements, but also increase the risk of external contamination.

However, due to modern medical techniques and team interdisciplinary cooperation (surgeon, anesthesiologist**,** radiologist and microbiologist), the patient with an OPLS may be better cared.

The comparison with other new techniques (for example, minimal invasive techniques) in the treatment of infected SAP proves the difficulty to choose a surgical golden standard, generally accepted and used according to the severity of the complications of this disease [11].

High percentage of pre and postoperative complications at patients undergoing OPLS group is correlated with the degree of extension of the extrapancreatic necrosis area.

When it comes after an episode of incontrollable sepsis by infected necrosis, MODS are a decisive factor of the mortality and not the percentage or the size of the extension of extrapancreatic necrosis [3,4,11].

Among the types of recognized pancreatic infections, infected pancreatic necrosis is by far the most common, the most severe and most fatal [1]. Non surgical drainage (CT or US guided percutaneous drainage) is inadequate in infected necrosis because of the consistency of pancreatic and extrapancreatic necrosis, because the percutaneous drainages become rapidly jammed and ineffective [18,19].

In various published studies, the authors recommend different types of drainage: closed (aspirative drainage); semi-closed (continuous lavage of the lesser sac); and semi-open (OPLS) [4,9], each of them with advantages and disadvantages. Because many deceases are due to postoperative persistent or recurrent sepsis with development of the MODS, ideal surgical procedure seems to be that one which determines the lowest rate of mortality and lowest rate of recurrent sepsis. According with these

Table 10. The incidence of MODS (pre and postoperative) and mortality after performing the OPLS technique in retrospective/ prospective study.

	Incidence		Mortality	
	n	%	n = 16/98	16.3%
Renal dysfunction				
preoperative	11	68.75		
postoperative	13	81.25	6	37.5
Pulmonary dysfunction (ARDS)				
preoperative	10	62.5		
postoperative	12	75	8	50
Cardio-circulatory dysfunction				
preoperative	7	43.75		
postoperative	2	12.5	2	12.5

Table 11. The incidence of MODS (pre and postoperative) and mortality after necrosectomy with closed abdomen and peritoneal drainage in retrospective/prospective study.

	Incidence		Mortality	
	n	%	n = 50/126	39,7%
Renal dysfunction				
preoperative	29	58		
postoperative	34	68	16	32
Pulmonary dysfunction (ARDS)				
preoperative	17	34		
postoperative	19	38	22	44
Cardio-circulatory dysfunction				
preoperative	15	30		
postoperative	12	24	12	24

requirements, choosing the OPLS technique during the management of infected necrotic lesions appears fully justified. In the prospective group was obtained an improvement of therapeutic results because of the patients with extensive infected necrosis were treated by OPLS technique.

Despite the limitation caused by a relatively small number of cases, due to the surgical experience of operators, we believe that especially at patients with infected extensive extrapancreatic necrosis, which develops mainly at the lesser sac region, necrosectomy with a complete removal of infected necrotic tissue, with lavage and subsequent re-explorations, is better than an intervention which close the abdominal wall with continuous lavage, aspirative drainage or planned relaparotomy.

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Titanium Elastic Nails for Pediatric Femur Fractures: Clinical and Radiological Study

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Abstract

Background: Management of femoral diaphyseal fractures in the age group 6-16 years is controversial. There has been a resurgence worldwide for operative fixation. **Material and methods:** Twenty children (15 boys, 5 girls) aged 6-16 years with femoral diaphyseal fractures (20 fractures, one in each) were stabilized with Titanium Elastic Nail (TEN). Patients underwent surgery within ten days of their injury. The results were evaluated using Flynn's Scoring Criteria.Two nails were used in each fracture. **Results:** All 20 patients were available for evaluation and follow up for a mean duration of 24 months (15-32 months). Radiological union in all cases was achieved in a mean time of 8 weeks. Full weight bearing was possible in a mean time of 10 weeks (8-12 weeks). The results were excellent in 14 patients (70%) and successful in 6 patients (30%). Few complications that occurred were infection (in 2 cases), knee joint stiffness(in 4 cases), angulation less than 10 degrees(in 4 cases), shortening less than 10 mm(in 4 cases). **Conclusion:** Intramedullary fixation by TEN is an effective treatment of fracture of femur in properly selected patients of the 6-16 years age group.

Keywords: Children, Intramedullary Fixation, Titanium Elastic Nail, Femoral Fracture, Diaphysis

1. Introduction

Femoral shaft fracture is an incapacitating injury in children [1,2]. The treatment has traditionally been age related, influenced by the type of injury, associated injuries and the location and type of fracture.

The aim of fracture treatment is not only anatomical realignment, but also restoration of muscle and joint function as close as possible to the normal. Psychological recovery is accelerated by early resumption of functional activity, which encourages healing of fracture, maintenance of normal circulation, preservation of tone of the muscles and restoration of the movements of the joints. The aim therefore is early mobilization by early use of the injured part without movement at the fracture site.

Because of rapid healing and spontaneous correction of angulations most of femoral shaft fractures in children younger than six years of age can be treated conservatively. Above six years of age all such fractures when treated non-operatively could have loss of reduction, malunion, intolerance and complication associated with plaster. Near the end of skeletal maturity accurate reduction is necessary as angular deformity is no longer correctable by growth. In skeletally mature adolescents, use of an antegrade solid locked intramedullary nail has become the standard of treatment.

In patients between 6-16 years of age there has been a tendency towards operative approach. Titanium Elastic Nailing (TEN) which is variously known as elastic stable intramedullary nailing (ESIN), has become the choice of stabilization in pediatric long bone fractures, particularly the femoral shaft fracture. The present study is aimed at the evaluation of intramedullay fixation with TEN in children with femoral fractures. Until recently skeletal traction and application of a cast was the preferred method of treatment of diaphyseal femoral fractures in children and young adolescent. The device would exploit a child's dense metaphyseal bone, rapid healing and ability to remodel without risking damage to the epiphysis or the blood supply to the capital femoral epiphysis.

2. Material and Methods

Twenty children (15 boys and 5 girls) in the age group of 6-16 years (average 10.8 years) with femoral shaft fracture were stabilized with TEN from April 2007 to October 2009. The predominant mode of injury was due to fall from height (50%). Right-sided involvement was seen in 13 cases (65%) and left side in 7 cases (35%). Mid-diaphyseal fracture of femur was found in 70% of

cases and subtrochanteric fracture in 30% cases. About 50% of the patients underwent surgery within 10 days of their injury. The surgery had been carried out in the Department of Orthopaedics, Darbhanga Medical College & Hospital, Laheriasarai, Darbhanga, Bihar, India.

Nail comes in five diameters from 2.5 mm to 4.5 mm in a fixed length. The nails are colour coded for identification. The nails (**Figure 1**) are straight except for a bent tip. Special instruments include radiolucent reduction tool, nail holder, nail bender, Insertion device, nail extractor, wice grip and a nail impactor were used.

All the patients treated with TENs had skin/skeletal traction for approximately 1 week. As is the policy of our institution the traction pin (4.76 mm threaded Steinmann Pin) was inserted in the operating room under local anaesthesia. The Pin was inserted in the region of tibial tuberosity anterolateral to posteromedial plane. Some patients were stabilised with skin traction. Compound fractures were primarily thoroughly debrided and upper tibial skeletal traction applied. The injured limb was put on a Bohler's-Brawn splint and adequate weight applied. This is essential to minimize pain, muscle spasm and shortening. Appropriate tetanus prophylaxis, antibiotics and analgesics were instituted. In the period of rest and resuscitation, the patient was properly investigated and examined. As soon as the patient became fit for anaesthesia and surgery he/she was posted for fixation of femoral shaft fractures with TEN. Good preoperative X-ray (**Figure 2**) of the injured femur was used to estimate the nail diameter and to develop an approach to supplement fixation and plan the incision.

Half an hour before operation 1 ampoule of atropine was given intramuscularly. Intravenous line was setup. Prophylactic antibiotic 1 gm ceftriaxone was given intravenously. 1 ampule perinorm was given intramuscularly. General/spinal (above 14 years) anaesthesia was given with full aseptic and antiseptic precautions on an image intensifier (IITV) compatible operation table.

As soon as anaesthesia was effective, the patient was placed supine and upper tibial skeletal traction pin was removed with aseptic and antiseptic precaution. The patient was placed on radiolucent fracture table. The limb was prepared and draped to give access to the entire femur and knee joint and to permit manual manipulation of

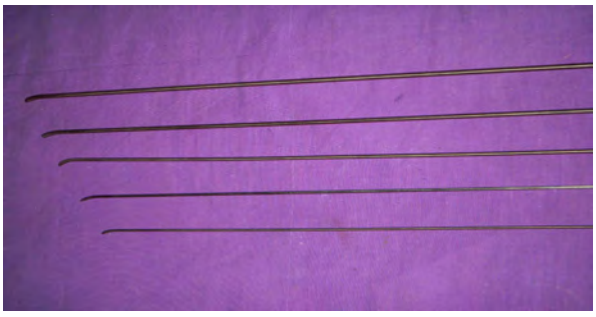

Figure 1. TEN with different length and diameter.

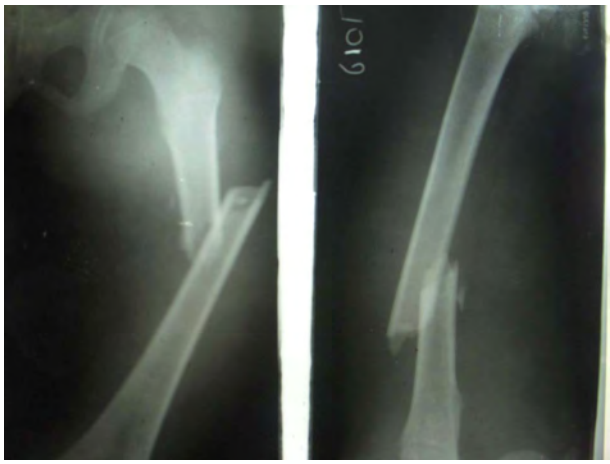

Figure 2. Preoperative x-ray of femur (AP and Lat view).

the thigh. The image intensifier was placed so that one could get antero-posterior and lateral view of the femoral shaft. The monitor was placed in such a way that surgeon could have clear vision when inserting the nail and reducing the fracture.

The selection of the insertion point for the nails was medial and lateral at the top of the flare of the medial and lateral condyles so that after insertion they would tend to bind against the flare of the condyles. If the nails are inserted too low, they will tend to backout, which is a troublesome complication. In addition, the insertion should be posterior to mid line of the shaft so that if the nails backout, they will be less likely to enter the synovial pouch.

A 5mm incision was made on the lateral side of the leg extending about two finger breadth above the superior pole of the Patella. (The superior pole of the patella lies slightly above the level of the physis). A guide wire for 6.5 mm cannulated screw was passed at 45 degrees angulation at the level of the superior pole of the patella. Over this a drill hole was made with the cannulated drill bit. Using a curved bone awl, the hole is extended cephalad to elongate the hole and avoid cracking of the cortex when the rod is inserted. The medial entry hole was similarly elongated using a curved bone awl in cephalad direction. The diameter of nail should be 2/5 of the internal diameter of the medullary canal (Nail diameter = 0.4 x Canal diameter).

Ideally, the lateral nail should extend to the level of the greater trochanter and the medial nail into the femoral neck. The amount of prebending should be equal for both the nails. (The amount of bending should be three times the inner diameter of the shaft).Both the nails were inserted through the entry holes one after another and were driven upto the fracture site. The reduction was helped by the use of F-tool which is a radiolucent device. The arms of the F-tool were readjusted depending on the fracture configuration and bulk of thigh viewing with the image intensifier. This nail was advanced about 2 cm and

then rotated. At this point, it was advanced further by rotating this nail. Further reduction of the fracture was accomplished and then the second nail was advanced.

The traction was released and both nails were advanced to their full length. Rotational and angular malreductions were checked and if present the same was corrected by partially withdrawing the nails, correcting the deformity and reinserting the nails. When the nail was at its final position, it was marked with a pen or clamp about 10 to 20 mm from the insertion hole. The nails were cut at the marked level and advanced so that they lay against the supracondylar flare of the femur in order to avoid complications at the insertion site.

A knee immobilizer or controlled motion brace should be used for additional support. The patients were advised to perform movements at the knee joint and three point touch down exercise the day after surgery under the guidance of a physiotherapist. When early callus formation is observed, weight bearing can be increased. External support can be discontinued when radiographic healing is complete. It is important that the patients bear weight because this provides the motion at the fracture site that leads to early callus formation. In all cases postoperative x-rays antero-posterior and lateral views were taken. In the post-operative period parenteral antibiotics were continued for 5 days and then oral antibiotics were given till stitch removal. Along with antibiotics, haematinics, serratiopeptidase, Calcium, multivitamins were given. Stitches were removed on the 12th post-operative day. After removal of stitch by 13th to 14th day post-operative patients were discharged.

Patients underwent regular follow up in the out patient department for clinical and radiological evaluation in the immediate post-operative period (**Figure 3**), at 4 weeks, 8 weeks (**Figure 4**), 12 weeks (**Figure 5**), 24 weeks, 35 weeks or till the publication of this series, whichever was earlier.

3. Results

The median duration of the surgery was 80 min (60-120 min). All 20 patients were available for evaluation after a mean of 24 months (15-32 months) of follow-up. All patients were encouraged to do hip and knee nonweight bearing exercises from first post-operative day. Weight bearing was allowed according to the fracture geography and fixation. At the end of 1st post operative week all patients were made ambulatory on crutches allowing weight bearing according to the quality of fixation. By 8th week all the patients were bearing weight with only 2 patients with touch-down weight bearing. Out of 20 cases, 2 cases complained of pain and irritation of skin at the entry site, associated with the prominence of the ends of the nails.

Out of 20 cases, 10 mm (1 cm) shortening was observed in 4 cases. These were among the earlier cases of the series and with comminuted fractures. Out of 20 patients, 3 patients showed 10 degree or less angulation in the lateral plane and one patient had an eight degree angulation in the anteroposterior plane. No broken nails were observed in any of the 20 cases. Out of 20 cases, 2 opening the entry site. These patients had to undergo knee physiotherapy again and regained movements at the knee. No re-fracture was observed in the 2 cases that underwent

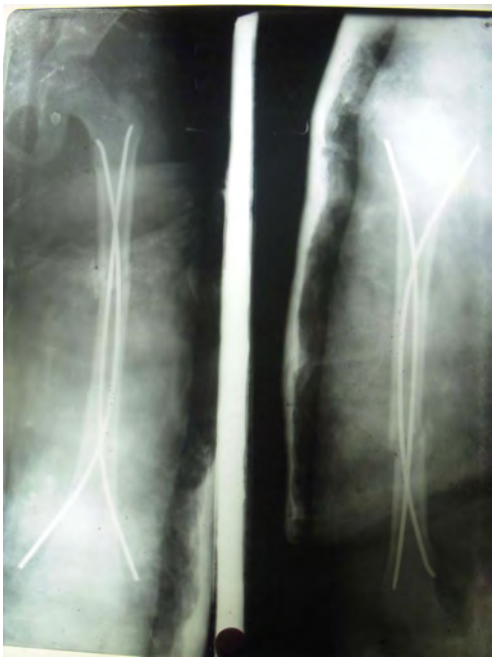

Figure 3. Immediate postoperative x-ray of femur (AP and Lat view).

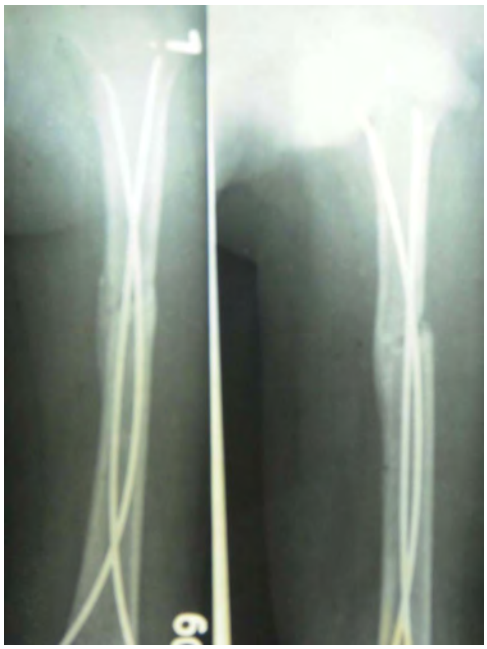

Figure 4. 8th week postoperative x-ray of femur (AP and Lat view).

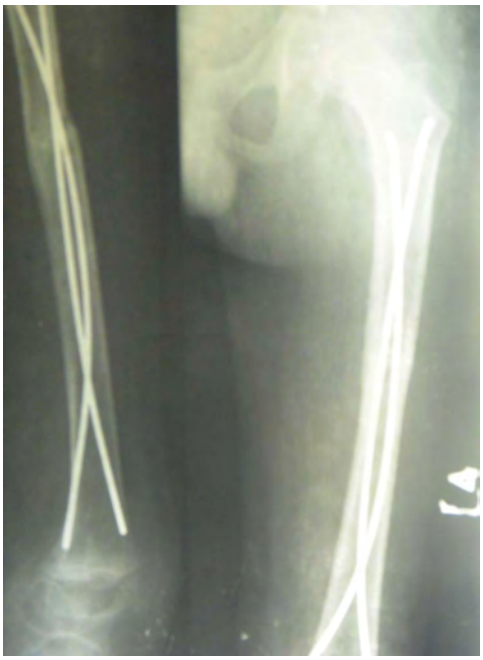

Figure 5. 12th week postoperative x-ray of femur (AP and Lat view).

nail removal.

4. Discussion

In the present series TEN was used as a mode of fixation in different types of femoral fractures in children between ages 6 to 16 years. 20 cases were treated and evaluated radiologically, clinically and functionally for the efficacy of TEN.In our series results were excellent in all 20 cases. Heinrich *et al*. (1994) reported that 22% of their patients had an extension over 5 mm, and 11% had a shortening under 5 mm. In a study comparing several methods including TEN the maximum shortening was observed in the early casting group followed by external fixator group where as lengthening was observed only in the external fixator group. In our study only 4 cases showed 1 cm shortening which was clinically indiscernible. Herndon *et al.* (1989) reported that malunion developed in seven of 24 patients who were treated with traction while no malunion was observed in 21 children who were treated using TEN.

In a study comparing anterograde versus retrograde TEN by Galpin *et al*. [6] it was reported that 35 out of 37 patients had excellent improvement in terms of angular deformity. We had angulation less than 10 degree towards varus/valgus or antero/posterior only in 4 patients (20%). In our series union progressed satisfactorily in all 20 cases. At the end of 8 weeks, 14 cases showed fair to good callus formation while 6 cases had minimal callus formation. No bone grafting was required in any of the cases. No significant malunion was observed in any of the 20 patients.

Flynn *et al*. (2002) found TEN advantageous over hip-spica in treatment of femoral shaft fractures in children. Buechsenschuetz *et al*. [7] documented TEN to be superior in terms of union, scar formation and overall patient satisfaction when compared to traction and casting. Ligier *et al*. [8] treated 123 femoral shaft fractures with TEN. All fractures united with excellent long term outcome. Similarly Narayanan *et al.* (2004) found TEN to be a very promising modality of fracture management in children. In our series of 20 cases, in 2 cases implants were removed after complete union.

In the present series, by the time stitches were removed all 20 cases could do straight leg raising exercises. At the end of study period 15 patients (75%) could do full range of motion at knee joint.

All patients were encouraged to do hip and knee non-weight bearing exercises from first post-operative day. At the end of 1st postoperative week all patients were made ambulatory on crutches, allowing weight bearing according to the quality of fixation.

Flynn *et al.* (2002) used a knee fixating device to control the pain, to support quadriceps and to prevent the end of nail causing any soft tissue irritation in the knee until the callus tissue appears (4-6 weeks). The patients were able to walk on day 9 on an average with the help of equipment and at week 8.5 on average without the equipment. In our series patients were made ambulatory on crutches after 1st postoperative week. Partial weight bearing was allowed at 6 weeks (range 4-8 weeks) and full weight bearing was allowed at 10 weeks (Range 8-12 weeks).

The results of the present series are comparable to those of the other series on management of femoral shaft fracture in children. It has definite advantages over the other conventional implants that have been used in the management of pediatric fractures. Notable advantages of this technique are early union due to repeated micromotion at fracture site, early mobilization, early weight bearing, scar acceptance, easy manipulation involved in implant removal and high patient satisfaction rate. Besides these, unlike other implants TEN does not endanger either the epiphysis or the blood supply to femoral head. The excellent biocompatibility and elasticity of titanium have further enhanced the virtues of TEN. High grade of elasticity of titanium limits the degree and permanence of deformation that the nail undergoes during insertion. More importantly elasticity promotes callus formation by limiting stress shielding.

Table 1 shows important aspects of this study like age and sex of the patients, nature and mode of injury, specifications of nail used, follow up results and duration, surgical complications like intraoperative blood loss and others.

The biomechanical principle of TEN is based on the symmetrical bracing action of two elastic nails inserted into the metaphysis, each of which bears against the inner bone at three points. This biomechanics helps in achie-

Table 1.

S.No.	Name	Age in years	Sex	Mode of Injury	Type of fracture	Side of fracture	Closed /open Injury	Blood loss	Nail dia.	ROM	Time for union			
											4 Wks.	8 Wks.	12 Wks.	24 Wks.
1	MP	8	M	RTA	MD	R	Closed	100-200	2.5 mm	FR	+	++	+++	+++
2	RS	11	M	HGT	MD	R	Closed	< 100 ml	2.5 mm	FR	+	++	+++	+++
3	NK	13	M	ASLT	MD	L	Closed	100-200	2.5 mm	FR	+	++	+++	+++
4	PK	12	F	RTA	ST	R	Open	100-200	2.5 mm	0-100°	-	+	++	++
5	GH	14	M	HGT	MD	L	Closed	< 100 ml	3 mm	FR	+	++	+++	+++
6	KP	9	M	ASLT	MD	L	Closed	< 100 ml	2.5 mm	FR	+	+	++	+++
7	ST	11	M	HGT	MD	R	Open	200-300	2.5 mm	FR	+	++	+++	+++
8	RD	14	F	ASLT	ST	R	Open	< 100 ml	3 mm	0-120°	+	++	+++	+++
9	AK	12	M	HGT	MD	R	Closed	100-200	2.5 mm	FR	-	+	+	++
10	UP	13	M	HGT	MD	R	Closed	< 100 ml	3 mm	FR	+	++	+++	+++
11	BS	10	F	RTA	ST	L	Closed	100-200	2.5 mm	FR	+	++	+++	+++
12	DNP	11	F	HGT	MD	R	Open	200-300	2.5 mm	0-120°	+	++	++	+++
13	BP	11	M	HGT	MD	R	Closed	< 100 ml	2.5 mm	FR	++	+++	+++	+++
14	NP	15	M	RTA	SY	L	Open	100-200	3 mm	FR	+	++	+++	+++
15	WA	16	M	HGT	MD	R	Closed	< 100 ml	3.5 mm	FR	+	+	++	+++
16	SKG	10	M	HGT	ST	L	Open	100-200	2.5 mm	0-100°	+	++	+++	+++
17	VD	16	M	HGT	MD	L	Closed	< 100 ml	3.5 mm	FR	+	+	++	++
18	SL	15	M	RTA	ST	R	Closed	< 100 ml	3 mm	FR	+	++	+++	+++
19	AP	8	M	ASLT	MD	R	Open	200-300	2.5 mm	0-120°	-	+	++	++
20	GLY	16	F	RTA	MD	R	Closed	100-200	3 mm	FR	++	+++	+++	+++

M = Male; F = Female; RTA = Road Traffic Accident; HGT = Height; ASLT = Assault; MD = Mid diaphyseal; ST = Subtrochanteric; R = Right; L= Left; ROM = Range of Motion; FR = Full Range; + = Little amount callus seen; ++ = Fair amount callus seen; +++ = Good amount of callus seen; - = No visible callus seen.

ving a high grade of stability *i.e.* flexural stability, axial stability, translational stability and rotational stability.

5. Conclusions

The intramedullary fixation by TEN is a method of choice due to its distinct advantages over other conventional modalities. Easy manoeuvering, excellent outcome, lower incidence of complications and easier postoperative maintenance have made TEN the most prudent, practical and successful intervention in the management of femoral shaft fractures of patients between 6 and 16 years of age.

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Isolated Mediastinal Lymphangioma: Prenatal Diagnosis and Thoracoscopic Treatment

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Abstract

Isolated mediastinal lymphangiomas are uncommon. We report a case of a 14 × 8 mm right paracardiac cyst diagnosed at 20 weeks' gestation. The prenatal evolution was uneventful and a magnetic resonance imaging at 31 weeks showed the limited extension of the cyst into the anterior mediastinum. At birth, the baby was asymptomatic, but the size of the lesion increased steadily (48 × 29 mm). At 7 months of life, he underwent a thoracoscopic resection of the cyst without intra or postoperative complications. Histological examination showed a lymphangioma. This case is remarkable for its prenatal diagnosis, the thoracoscopic treatment and the 8 years of follow-up without recurrence.

Keywords: Mediastinal Tumor; Mediastinal Lymphangioma; Thoracoscopic Treatment; Prenatal Diagnosis

1. Introduction

Isolated anterior mediastinal lymphangiomas (ML) are uncommon, with an occurrence less than 1% of all the lymphangiomas [1], and most of them are asymptomatic during childhood. They can lead to compression of vital structures, even life-threatening airway compromise. A prenatal diagnosis is now possible, but several pathologies can be evocated when a paracardial cystic lesion is discovered. Once diagnosed, they should be resected, typically by thoracotomy or median sternotomy. We report a case of ML with prenatal diagnosis and thoracoscopic treatment.

2. Case Report

An 8 months old boy presented a 14 × 8 mm anechogenic right-sided anterior mediastinal cyst, which had been diagnosed at 20 weeks' gestation by ultrasonographic examination (**Figure 1**) and confirmed by magnetic resonance imaging (MRI) at 31 weeks' gestation (**Figure 2**). At 34 weeks, the cyst was heterogeneous and measured 27 × 23 mm (**Figure 3**), but no complications were observed during the pregnancy and the baby was delivered at 37 weeks, weighing 2870 g, without respiratory distress. In the first week of life, sonography and MRI showed a 33 × 26 mm cyst and it was decided to delay resection for a few months. By 7 months, the cyst had enlarged to 48 × 29 mm, without respiratory complication, and the baby was operated on account of this evolution. In the operating room, the patient was placed in left lateral decubitus position and 4 ports were necessary. The cyst was to the right of the thymus, close to the phrenic nerve. The posterior parietal pleura was opened over the cyst from its lower part and easily dissected off the thymus; the dissection was performed cephalad along the right phrenic nerve and the pedicle was ligated close to the superior vena cava. Pathological examination showed a typical lymphangioma. The postoperative course was uneventful and no phrenic palsy or pleural effusion was noted. The patient remains asymptomatic 8 years after surgical excision, without recurrence of the lymphangioma.

3. Discussion

Lymphangiomas are benign hamartomatous tumors of the lymphatic system and less than 1% of all cystic lymphangiomas are purely mediastinal in origin [1]. They constitute about 3% of all mediastinal masses in children [2]. A prenatal diagnosis has already been reported in 8 cases for an isolated ML [3-10]. It may be suspected when the sonographic examination shows a single or multilocated paracardiac anterior mediastinal cystic

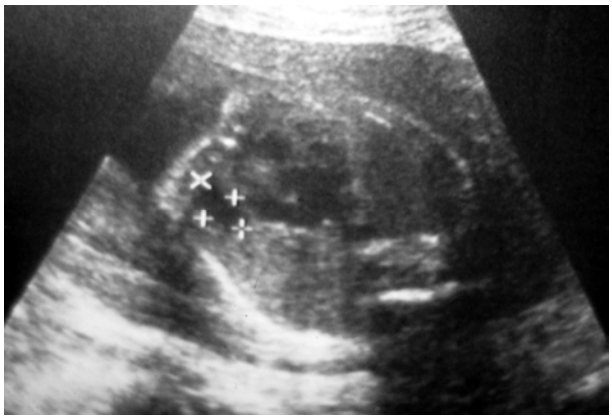
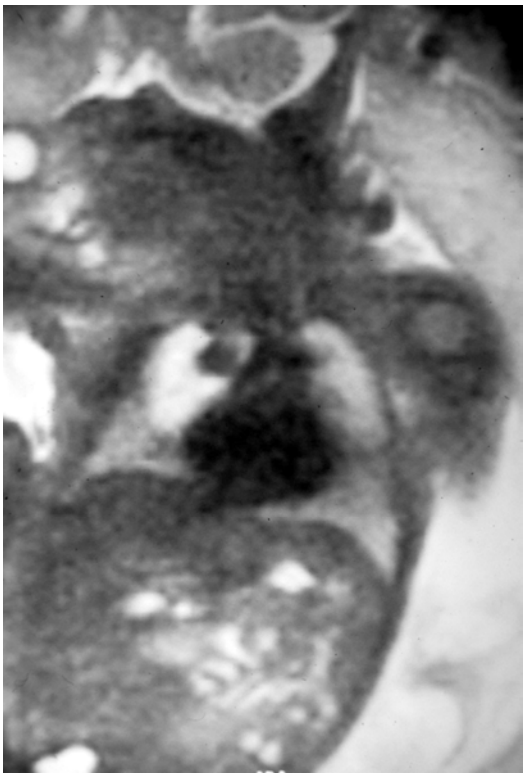


Figure 1. transverse sonography at 20 weeks' gestation showing a 14 × 8 mm right paracardiac anechogenic mass.

mass. Sometimes, the lymphangioma was described in the pos- terior mediastinum [4,10,11]. In our case, a fetal MRI was also performed and showed the exact location of the lesion and its extension. As the intracystic septations are not always visible on fetal ultrasonography, other diagnoses have to be proposed: pericardial cyst, bronchogenic cyst, thymic cyst, teratoma, esophageal duplication and neurenteric cyst [8,12,13]. A poor outcome is possible with fetal hydrops and hypoplastic lungs, and prenatal thoracocentese may be discussed [3]. For the 8 cases with prenatal diagnosis, the evolution during the pregnancy was variable with 1 spontaneous disappearance, 3 stable lesions and 4 increases of the ML. Among the 4 last cases, 3 fetal hydrops occurred with 1 neonatal death [3], 1 prematurity at 35 weeks' gestation [7] and the third underwent drainage of the cyst at 24 weeks with success [5]. The ML may be associated with a cervical cyst [9,14] and sometimes with an abdominal extension [15]. A termination of the pregnancy was performed for one fetus presented a cervico-mediastino-retroperitoneal lymphangioma [11].

After birth, most ML are not diagnosed because they are asymptomatic; among the patients presenting symptoms, the most common are respiratory, cough or stridor by extrinsic compression of the airway as a result of hemorrhage or inflammation, sometimes with acute respiratory distress [15,16]. Less common symptoms are dysphagia, superior vena cava syndrome, dysarythmia, Horner's syndrome or phrenic nerve paresis [17]; a fatal outcome in a 12 year-old boy has been described [18]. Chest radiograph may show an anterior mediastinal mass and sonography may establish its cystic aspect with septations; however computerized tomography and especially MRI are useful for the diagnosis and the extension of the lesion [14-16]. Calcifications have been described in ML, although this is more characteristic of teratomas [19].

Mediastinal lymphangiomas, as other mediastinal masses, must be removed to avoid complications. Among the



(a)

(b)

Figure 2. (a) fetal MRI at 31 weeks with the right mediastinal cyst. Coronal view; (b) fetal MRI at 31 weeks with the right mediastinal cyst. Sagittal view.

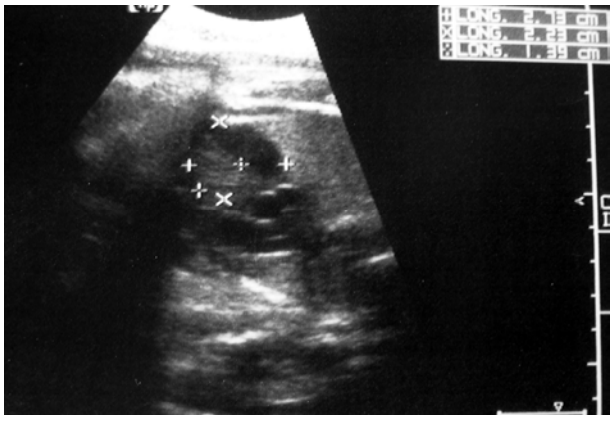


Figure 3. Sonography at 34 weeks' gestation with a 27 × 23 mm heterogeneous right anterior mediastinal cyst.

children with a prenatal diagnosis, 3 thora cotomies were performed at birth for the 2 fetal hydrops and 1 huge lymphangioma; one of them underwent a second thoracotomy at 19 months for recurrence [5]. One 51 × 24 mm ML at 31 weeks' gestation disappeared spontaneously at 6 months of life [6]. The last 3 ML were respected and overseen after birth, but the ML increased , as in our case, and a thoracotomy was decided at 6 weeks of life for 2 and 19 months for one. Usually, thoracotomy or median sternotomy are performed, but the thoracoscopic treatment of such lesion is now possible [13,20]; this procedure has been shown to be safe in a series of 22 mediastinal cysts in children, one of which being a ML [13], and in 2 other cases at 19 months and 7 years old [8,16]. Our child was 7 months old when the thoracoscopic treatment was performed. Nevertheless, postoperative complications can arise after the treatment of ML; the surgical resection may be incomplete because of adhesions with the great vessels or pericardium and recurrences are possible [1,5,9,21]; a few patients displayed temporary or definitive phrenic nerve palsy or Horner's syndrome as well [1,21,22]. In our case, a complete resection was performed and the phrenic nerve was seen during the entire procedure, without postoperative complication. We have 8 years of follow-up and we can consider that the recovery is obtained now.

4. Conclusions

Isolated mediastinal lymphangiomas must be suspected when a cystic mass is noted on prenatal sonography in the anterior mediastinum, differential diagnosis including especially pericardial cyst or thymic cyst. The evolution is variable from the spontaneous disappearance to fetal hydrops or life-threatening complications. A thoracoscopic approach is now possible, even in infant.

Author Disclosure Statement: there is no conflict of interest for each author.

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Combined Single Step Definitive Treatment in Acute Pilonidal Sinus Abscess Running Head: Single Step Treatment of Pilonidal Abscess

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Abstract

Backgrounds: The treatment of choice has been drainage and definitive surgical treatment after an interval for acute pilonidal sinus abscess till now. Because of the high incidence of chronic pilonidal sinus disease following drainage and aiming the cure in one step, synchronous treatment choices to drainage have been attempted recently. We analyzed retrospectively 20 patients with pilonidal sinus abscess on whom we carried out drainage+ marsupialization as single-step treatment. **Methods:** Drainage+ synchronous marsupialization results of 20 patients (17 male, 3 female) between 20 to 37 years of age (mean 28) were analyzed retrospectively on the parameters of operation time, recovery period, time to work-return and recurrence ratios. **Results** Operation times were between 15 to 25 minutes. Mean recovery period was 45 days (30-50 days), the mean period from operation to work-return was 24 (22-30) days. There were full recovery in 18 patients (90%) and recurrence in 2 patients (10%). Silver nitrate ablation treatment achieved cure in recurrences. **Conclusion:** Drainage+ Marsupialization is an applicable and successful combined choice in the treatment of Pilonidal sinus abscess.

Keywords: Pilonidal Sinus Abscess, Drainage, Marsupialization, Definitive Treatment, Combined Treatment

1. Introduction

Pilonidal sinus disease (PSD) is an acquired disease in especially young men with continuous oozing at intergluteal sulcus [1]. The risk factors increasing PSD incidence are white race, young age, familial tendency, excessive sweating, long sitting periods, sedative life style, bad body sanitation, fatness, male gender and trauma to the coccyx region [2].

In spite of proposed different treatment modalities, there is no standardized treatment due to high recurrence ratio.

Pilonidal sinus abscess (PSA) (**Figure 1**) is seen as the first finding in half of the patients [3]. PSA may cause widening of lesion, increasing of sinus number and sepsis [1,2]. It may be fatal if remains untreated. Various complications like Septic arthritis, osteomyelitis, DIC, and toxic shock syndrome were reported [2,4,5,6].The treatment of PSA has been simple drainage and definitive surgery after healing of abscess [7]. Because the recurrence is high following simple drainage, definitive surgery is necessary for total cure [8]. Today, alternative approaches that combine drainage and definitive surgery in one step get popularity. We reported 20 patients with PSA to whom we performed definitive surgery at the same time with drainage.

2. Methods

20 patients (17 (85%) male and 3 (15%) female) between 20 to 37 years of age (median 28) who came to our outpatient clinics with acute pilonidal sinus abscess (PSA) and operated between 2007 and 2009 were analyzed retrospectively.

All patients were treated with skin excision, curettage and intraflexion operation under spinal anesthesia. Metronidazole 0.5 mg IV and gentamicin 80 mg IV were given to the pts 30 minutes before operation for infection treatment. Gluteal skin stretched to both sides with plaster traction and the area was shaved. Abscess was dra-

ined at midline where it gave fluctuation and the skin around the area was removed by a vertical rhomboid excision paralleling the intergluteal sulcus (**Figure 2**). The abscess pouch was washed out with physiologic saline and 10% povidine iodine solutions. The wall of cavity was curetted and chronic granulation tissue was excised (**Figure 3**). Healthy skin was fixed to the sacral fascia with 2/0 polypropylene single stitch at superior, inferior and both lateral sides (marsupialization) (**Figure 4**). The mean operation time was between 15 to 25 minutes. Pts were given po ampicillin 375 mg three times a day for 5 days and discharged at post operative 2nd day. Serum physiologic dressing of the wound was made on every 2 days for first 10 post operative days and on every 3 day-interval after then until total wound healing occurred. Pts were advised to take shower before every dressing. Stitches were removed on 15th day and periodical controls were made at 1st 2nd 3rd 6th and 12th months (**Figure 5**).

3. Findings

Abscess pouch was running toward to the right gluteal region in 13 (65%), to the left in 5 (25%) and to the superior in 2 (2%) of pts. Mean recovery period was 45 days (between 30 to 50 days); the mean work-return period was 24 days (22-30). 18 (90%) of pts shown total recovery though 2 pts (10%) developed chronic pilonidal sinus disease on midline. These 2 pts were treated with silver nitrate 20% solution ablation and recovered well. There was no recurrence in follow up period.

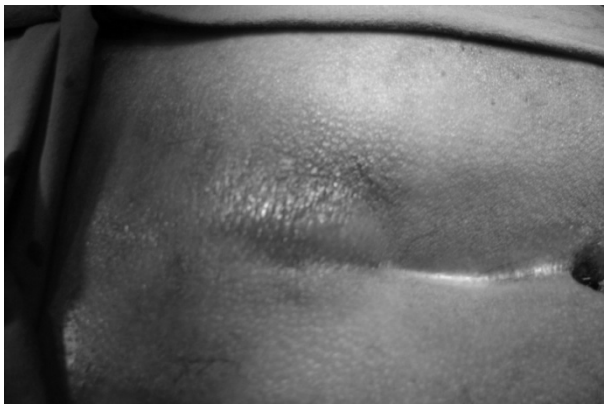

Figure 1: Pilonidal sinus abscess.

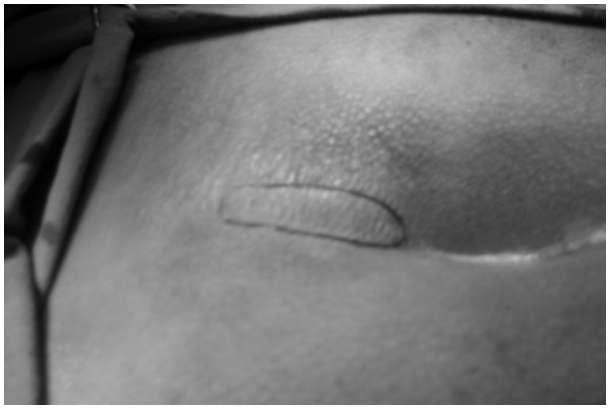

Figure 2. Line of excision.

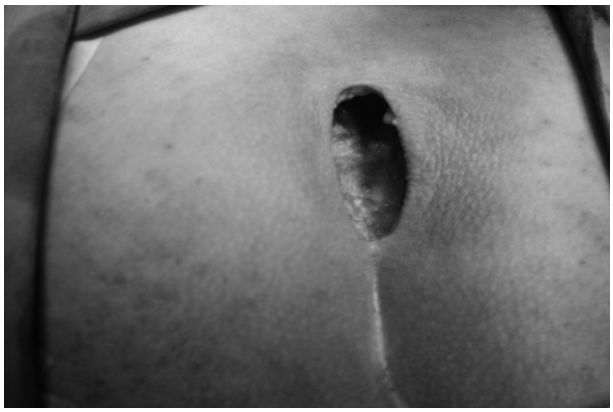

Figure 3. Cavity after curettage and washing.

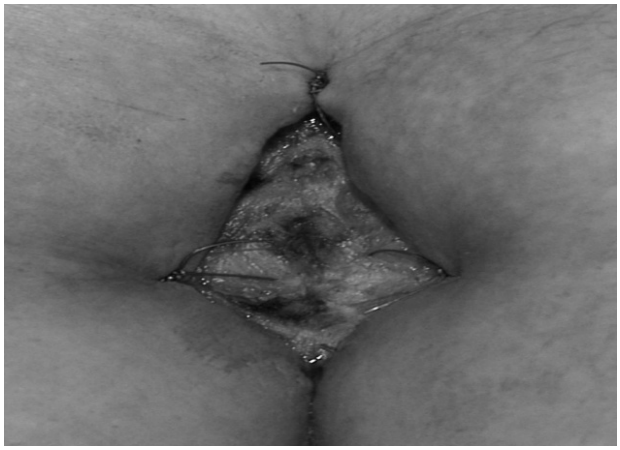

Figure 4. Marsupialization.

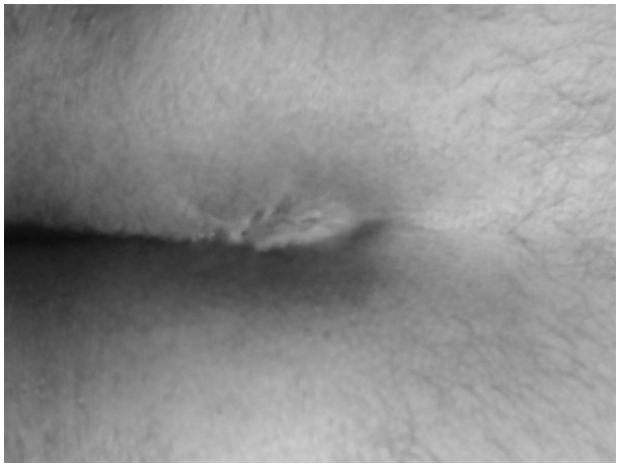

Figure 5. Healing scar at the 6th month.

4. Results and Discussion

Mainstay of the treatment is drainage for PSA. Simple drainage and definitive surgery after an interval period has been accepted treatment. But, many of the patients, treated with simple drainage, develop chronic PDS until definitive surgery and any delay in definitive surgery may result in expansion of diseased area and development of new tracts, therefore, widening the operative field. To decrease chronic PSD development risk, drainage and combined definitive surgery concept was proposed. Drainage+ marsupialization was performed by Licheri on 43 patients with acute abscess and succeeded in 81.3% of them. In this study, 4.7% of the pts developed chronic fistulas and 14.6 developed recurrence. 95% of the pts got totally recovered within 6 to 10 weeks [9]. Our pts number was half of that series, but still, operation times were similar. Our recurrence ratio was twice.

Midline skin excision provided easier drainage, cavity curettage and excision of chronic granulation tissue.

Disadvantages of the method were long recovery and work-return periods.

Another method reported as successful was drainage+ primary closure with 82% total recovery and 18% recurrence [10]. Drainage+ laying open was another recommended method [11].

Midline location of the sinus openings mostly in chronic and recurred PSD suggest that focus of the disease is midline. Thus, two studies which closed wound off-midline shown that this type of closure improved wound healing [12,13].

5. Conclusions

PSA needs definitive treatment after drainage so that it should not become chronic disease. Drainage and combined definitive surgery (skin excision curettage and intraflexion operation) as a single step is a good alternative method in its treatment. This treatment provides the patient to be cured in one step surgery and excludes the complications of delay in definitive surgery, like risk of getting chronic disease and forming more sinus tracts. The results are promising with low recurrence rate and small and good scar formation and future studies on more patients will show its efficiency.

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Endoscopic Adenoidectomy Secondary to Drug-induced Trismus

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Abstract

We present the case of a 4 year old girl whose adenoidectomy had to be performed via an endoscopic-transoral approach due to the unexpected inability to fully open the mouth during the procedure. The patient had previously been taking Risperidone for behavioral symptoms associated with her autism. The jaw tone returned to normal following the procedure and there were no complications. An interaction between the Risperidone and the anesthetics were the likely cause of the trismus.

Keywords: Adenoidectomy, Endoscopic, Trismus, Risperidone, Masseter Spasm

1. Introduction

Adenoidectomy is one of the most common same-day surgeries performed by otolaryngologists. One of its indications is to reduce the size of hypertrophic adenoids which can cause airway obstruction [1]. Normally, the procedure is performed transorally using a laryngeal mirror to indirectly visualize the anatomy of the nasopharynx. Some physicians perform the adenoidectomy transnasally. We present the case of a 4 year old girl whose adenoidectomy had to be performed via an endoscopic-transoral approach due to the unexpected inability to fully open the mouth during the procedure.

2. Case Report

A four year old, 17 kilogram female, with a history of obstructive sleep apnea and chronic otitis media was scheduled to undergo an adenoidectomy and bilateral myringotomy with tube placement. She had a significant history of environmental allergies. She also had a history of autism, and was on Risperidone. Pre-operative examination revealed bilateral serous middle ear effusion and was otherwise normal.

After inhalational induction of anesthesia with Sevoflurane and nitrous oxide, the myringotomy and tube placement was accomplished without incident. After increasing the anesthetic depth with 40 mg of Propofol and 25 micrograms of Fentanyl, the patient underwent direct laryngoscopy and tracheal intubation. Placement of the endotracheal tube was extremely difficult secondary to the inability to fully open the mouth. A grade 3 view was obtained and tracheal position of the tube was confirmed by auscultation of the lungs and denoting carbon dioxide on the capnograph. After positioning the patient in the Rose position, a shoulder roll was placed. A Crowe-Davis mouth gag was placed with some difficulty. Only a small opening of the mouth was able to be obtained with the mouth gag. Assessment of the temporomandibular joint (TMJ) revealed no dislocation, but movement of the mandible was unsuccessful. Due to severely limited mouth opening, the mouth gag could not be extended to allow visualization of the adenoids with the laryngeal mirror. Anesthesia was deepened by increasing the Sevoflurane, and 20 mg of succinylcholine was administered to remove any possibility of increased muscle tone as the cause of the trismus. Several further attempts at visualizing the adenoids transorally were unsuccessful, so a nasal endoscopy was performed. A 2.7 mm 0 degree nasal endoscope was inserted through the left nostril to visualize the nasopharynx. This revealed moderately enlarged adenoids. The nasal cavity was felt to be small to be able to accommodate the instruments for a transnasal adenoidectomy. At this point we opted to proceed with the adenoidectomy through the mouth with suction cautery while the adenoids were visualized transorally with a 70 degree 4 mm nasal endoscope. The adenoids were removed with suction cautery without incident. The estimated blood loss was less than 1 cc. The patient was taken to the recovery room and the trachea was extubated. After recovery from anesthesia the

patient was found to have normal movement of the TMJ. The patient recovered well with complete resolution of her sleep apnea. On follow-up, at 1 and 6 months after the procedure, the patient continued to have no issues with trismus or TMJ pain.

3. Discussion

Adenoidectomy is a routine procedure for otolaryngologists. It is most commonly performed transorally with the help of a mouth gag [1]. Several instruments can be used to remove the adenoids, including a curette, adenotome, suction cautery, Coblator® and a microdebrider. Another method is to remove the adenoids transnasally with the use of nasal endoscopes for visualization and removal of the adenoids with powered instruments [2,3]. There has also been reported the use of the transnasal visualization with transoral removal of the adenoid tissue [4]. All techniques have different advantages and complications. Most surgeons in the UK do not use direct visualization of the adenoids during the surgery. They use direct palpation instead [5]. Visualization of the adenoids provides the ability to remove them with more control of the bleeding and surrounding structures. For this reason, in our institution, adenoidectomy is routinely performed using indirect visualization through a mirror. Some authors report the use of endoscopes through the nose to visualize the adenoids, while these are removed through the mouth. As our patient had significant trismus, we were not able to perform the surgery in the conventional fashion for our institution. As mentioned above, we utilize indirect visualization of the adenoids through a mirror in the oral cavity and the removal is performed through the same route with a curette, suction cautery or microdebrider. In this specific patient, after evaluating the adenoids through the nasal cavity it was felt that her nasal cavity would be small for a larger endoscope, suction cautery or a large microdebrider. We opted to visualize the adenoids through the mouth with a 70-degree endoscope and use the suction-cautery to promote the most efficient hemostasis and prevent bleeding. Despite the poor mouth opening, this was performed without difficulties.

Our patient had an unexpected episode of trismus that did not improve with the time, increasing the anesthetic depth or the use of muscle relaxants. Trismus in awake children is usually secondary to trauma to the mandible or problems in the condyle. Our patient's trismus occurred after induction and subsided once she recovered from anesthesia. At the time of surgery she was taking Risperidone. Risperidone is an atypical antipsychotic that is used in children with autism to decrease agitation [6-8]. One of the side effects of this medication is muscle spasm. There is a report of an autistic patient who was taking both Methyphenidate and Risperidone in whom unilateral dystonia of the masseter muscle was reported [9]. Risperidone has also been associated with the neuroleptic malignant syndrome, which can result in rigidity [10]. Although this patient exhibited masseter rigidity, she had none of the other symptoms associated with this condition. One hypothesis is that the trismus was caused by synergism of the Risperidone with the volatile anesthetic, Sevoflurane. We do not believe that the trismus was the result of inadequate anesthetic depth. The patient had no response to surgical stimulation and her vital signs suggested she was in a deep plane of anesthesia. Succinylcholine itself can cause trismus, but was not the cause in this case, as the trismus occurred before the succinylcholine was given [11,12]. Nerve stimulation showed complete ablation of neuromuscular function. The fact that the trismus did not subside with the use of muscle relaxants, but completely resolved after she woke up from the anesthetic, suggests a mechanism unrelated to the succinylcholine. There are no reports in the literature about volatile anesthetics, Risperidone and trismus, but it is likely the muscle spam in the masseter muscle was the result of the combination of Risperidone and Sevoflurane. One can hypothesize that the patients' autism had an effect on the brain making the patient more susceptible to trismus. Behaviors such as with chronic teeth grinding, are common in autistic patients [13]. It is possible that either the Propofol or Fentanyl also contributed to the trismus, but this is unlikely given the small doses used.

In summary, this is the first reported case of trismus in association with Risperidone in an autistic patient resulting in the inability to perform adenoidectomy in the standard transoral fashion. When mouth opening is an issue, transoral adenoidectomy using a rigid endoscope in an acceptable alternative. In addition, anesthesiologists should be aware about this potential side effect of Risperidone.

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TABLE OF CONTENTS

Volume 1 Number 1 **July 2010**