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Static or Dynamic Intramedullary Nailing of Femur and Tibia

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ABSTRACT

Introduction: The basic principle of non-surgical fracture treatment is to restore the original anatomical position of fractured fragments by different techniques, without direct access to the bone and without further traumatizing of tissues. Intramedullary nailing is synthesis and consolidation of fracture fragments with the main goal to gain strength and permanent placement of the implants. Two techniques of intramedullary osteosynthesis are used: with dynamic or with static intramedullary nail. Dynamization include conversion of static nail by removing screws from the longest fragment. **Aim:** The aim of this study is to determine whether there is a difference in the speed and quality of healing of the type A and B fractures of the femur and tibia treated by static or dynamic intramedullary nails and to compare the results. **Material and methods:** The study was conducted at the Clinic for Orthopaedics and Traumatology, Clinical Center University Sarajevo from January 2004 to June 2009. The study was retrospective-prospective, manipulative, controlled and it was conducted on a total of 129 patients with closed fractures of the diaphysis of the femur and tibia type A and type B, with different segments of bone, regardless of sex and age structure, with the exception of children under 14 years of age. **Results:** Precisely there were 47 patients with femoral fractures and 82 patients with tibial fractures. The average number of weeks of healing femoral and tibial fractures was slightly in advantage of static intramedullary osteosynthesis, it was 17.08 weeks (SD=3.382). The average number of weeks of healing in 23 patients with fractures of the femur, treated by dynamic intramedullary osteosynthesis was 17.83 (SD=2.978). We can conclude that static intramedullary nailing osteosynthesis unable movements between fragments which directly stimulates bone formation and formation of minimal callus. **Conclusion:** Static intramedullary osteosynthesis resolve the problem of stabilizing the fracture, limb shortening and rotation of fragments.

Key words: fracture healing, intramedullary nailing, dynamic and static intramedullary nail.

1. INTRODUCTION

The progressive increase of trauma,in the last 30 years, lead to large-scale scientific and technical effort in finding methods to decrease consequences of this modern epidemic (1). The use of the conventional method leads to unacceptably large number of complications, and to the loss of many lives. One of the most serious complications of chronic infection of the bone. Today, only one treatment of chronic infection treatment costs more than 100 fresh severe fractures. The use of conventional methods leads to unacceptably large number of complications. One of the most serious complications are chronic infection of the bone. Today, only one treatment of chronic infection treatment costs more than 100 fracture treatments. There are two possible choices of fracture treatments: non-surgical and surgical. The basic principle of non-surgical fracture treatment is to restore the original anatomical position of fractured fragments by different techniques, without direct access to the bone and without further traumatizing of tissues. One of the main goals of every surgeon is to minimize tissue damage, which results in fewer complications and faster recovery. (2) Intramedullary osteosynthesis offers all the comfort for both the surgeon and the patient, to minimize tissue damage and blood supply, and thus the faster healing of the fracture, along with a low rate of complications during the treatment.

Constant dilemma in modern orthopedic surgery is what type of intramedullary osteosynthesis to use, static or dynamic, rhymed or unrhymed nail, because it is obvious that the indication area of their application is constantly expanding, due to technological advances in the development of implants and because of the progress of operational techniques.

Significance in modern orthopedic trauma treatment is rapid and safe management of fractures of the upper leg

and lower leg, with a minimum of complications. Choosing the right path of treatment, as well as the most appropriate method for each individual patient, is a daily challenge, but also a dilemma.

The goal of fracture treatment of thigh and lower leg is to establish as soon as possible the integrity of the bone, and to start physical therapy. The outcome of each fracture healing depend on the performance and quality of surgery. Accordingly, each of the osteosynthesis implants has its advantages and disadvantages in relation to three basic problems of bone healing: a) Infection; b) Instability and c) Circulation. Low incidence of infection, high stability and strength of fragments of contact, the possibility of early mobilization of the patient while preserving soft structure and peripheral circulation, are a guarantee of success and quality of healing of fractures of the femur and tibia, treated using static and dynamic intramedullary osteosynthesis.

2. MATERIAL AND METHODS

The study was conducted at the Clinic for Orthopaedics and Traumatology, Clinical Center University Sarajevo from January 2004 to June 2009. The study was retrospective-prospective, manipulative, controlled.

The study was conducted on a total of 129 patients with closed fractures of the diaphysis of the femur and tibia type A and type B, with different segments of bone, regardless of sex and age structure, with the exception of children under 14 years of age. Precisely there were 47 patients with femoral fractures and 82 patients with tibial fractures. Patients were divided into two groups, based on the applied operating method, static or dynamic intramedullary osteosynthesis: a) Patients with fracture of the femur or tibia treated with static method of intramedullary nailing, where the static intramedullary nail fastened cross screws (3 or 4 screws) on both ends, and by that controls the axial and rotation instability and bending (24 patients with femoral fractures and 58 patients with tibial fractures); b) Patients with fracture of the femur or tibia treated with dynamic method of intramedullary osteosynthesis (or patients whom had performed "dynamization"), which allows the complete axial pressure with control of bending and rotation.

The success and healing time of fractures of the femur and tibia treated using static or dynamic intramedullary osteosynthesis is declared on the basis of clinical and radiological results of fracture healing in each of the respondents.

The clinical evaluation and data analysis is divided into two groups: For the retrospective testing were taken and evaluated available data from the history of disease and control values operators and departmental doctor.; For a prospective group of respondents used the questionnaire clinical examination.; Clinical examination in the prospective group are mainly performed examiners, three of them, according to the appropriate questionnaire. From clinical signs of healing emphasize: the rigidity and lack of crepitation at the point of fracture, no pain at the site of the fracture with palpation and percussion rough, and the absence of pain in full support and walk on limb fractures healed. These findings, in comparison with the radiographic analysis conducted by Corrales Morshed, Bhadari & Miclau, i.e.. radiographic assessment of the healing of fractures of the femur and tibia "cortical bridging", which is based on the data evaluation of healing of each of four bone coticalis (anterior, posterior, medial and lateral) with record time to the appearance of callus, the time to occurrence of mature callus and the loss of the fracture line, in various stages of fracture healing by at least three independent examiners, with certainty declare fractures healed (4; 5; 6). By the same authors, the fractures healed radiographically considered if there is a bypass on three of the four cortical fracture cracks, which is the benchmark in our study. There are several methods described evaluation of bone healing in radiological treatment. In all operationally treated fractures of the femur and tibia using intramedullary osteosynthesis, which were the subject of prospective studies, are made radiography in two directions for each extremity surgery at regular intervals, as follows: preoperatively, postoperatively, the seventh postoperative day, and starting from 8th week post-operatively at regular intervals of 2- 4 weeks (10, 12, 14, 16, 18, 20, 22, 24, 28, 32, 36 weeks post-operatively.) The final visit was conducted in 48 week.

In certain cases when callus is abundant due to "fracture movements", it is necessary to do additional mathematical processing created callus, summarized by the clinical and radiographic signs of bone healing. One of them is the usage of approximate parameters, i.e.. the length of the projection fracture, i.e. the sum of the length of the projection of the turning cracks. All these parameters were measured in millimeters.

HISTOLOGICAL SCALE (COMPLETE BONE FORMATION =10) TISSUE CALLUS DIFFERENTIATION			RADIOGRAPHIC SCALE OF CALLUS FORMATION IN FRACTURE GAP		
WITHOUT CALLUS	0	BLOOD CLOT AND GRANULATION TISSUE	0	WITHOUT CALLUS	0
SMALL TO MEDIUM CALLUS	1	FIBROUS CONNECTIVE TISSUE	1	SMALL TO MEDIUM CALLUS	1
MASSIVE CALLUS TISSUE	2	CONNECTIVE CARTILAGE TISSUE	2	MASSIVE CALLUS TISSUE	2
BRIDGING PERIOSTEAL CALLUS	3	APPEARANCE OF BONE	3	BRIDGING PERIOSTEAL CALLUS	3
MATURE CALLUS WITH INTRAFRAGMENTARY BAYPASS	4	FULLY BONE FORMATION	4	MATURE CALLUS WITH INTRAFRAGMENTARY BAYPASS	4
AFTER OWERGROWING CALLUS RESORPTION	5	COMPLETE RESTORATION OF DYAPHYSIS	5	AFTER OWERGROWING CALLUS RESORPTION	5

Table 1. Clinical and radiographic signs of fracture healing

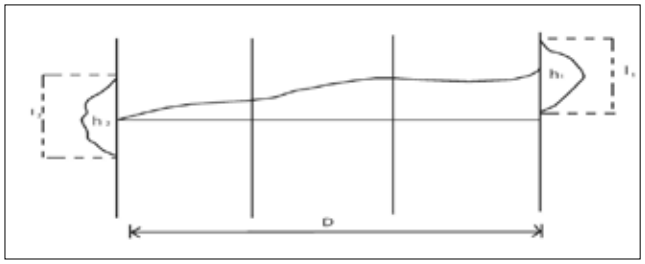

Figure 1. Schematic view of creating a callus. Width callus, l1–l2; Callus height h1–h2; Length connecting the center of gravity of the triangles, D gravity

3. RESULTS

The research results can be divided into the period of 2004-2006, when the summarized results of the examiner, and it is mainly retrospective character, and on research from 2008 to the second half of 2009. Research was conducted on a total of 129 patients, and in 47 patients with fractures of the femur type, and 82 patients with a fractured tibia type A and type B. Total number of pseudoarthrosis were three, two femur and one tibia. Number of fractures of the femur treated using static intramedullary nail were 24 and 23 patients were treated by dynamic intramedullary nail. According to the results of clinical and radiological study conducted by three independent examiners, the average number of healing of fractures of the femur and tibia expressed in the weeks go slightly in advantage of static intramedullary osteosynthesis and it was 17.08 weeks with a standard deviation of 3.382. The average healing time for 23 patients with fractures of the femur, treated by the dynamic method of intramedullary osteosynthesis is 17.83 weeks with a standard deviation of 2.978. Based on these data, it was concluded that the difference in healing by weeks depending on the type of intramedullary nail, not statistically significant, with a calculated value of t-test, which is: t = 0,897. The one that is noticeable is that the fractures type 3 2 A and 2 B 3 by AO classification had slightly faster flow of healing in patients treated with static intramedullary osteosynthesis In the period from 2004 until the second half of 2009, a survey was conducted on 82 fractures tibia with intramedullary nailing rhymed, with an average healing of 14.02 weeks and standard deviation of 3.17. In total 58 were treated with static intramedullary tibial nail, with an average time of healing from 13.55 weeks with a standard deviation of 2.89, and 24 tibial intramedullary nail dynamic with an average time of healing from 15.17 Sunday and standard deviation of 3.46. As seen from the results obtained, the difference in the number of weeks fracture healing tibia depending on the types of intramedullary nail, is statistically significant, it is comparatively identical in most similar studies.

Year	Patients	Average number of healing (weeks)	Standard deviation (SD)
Static nail			
2004	1	20,0	0
2005	-	-	-
2006	4	19,6	5,196
2007	5	18,8	3,633
2008	11	16,0	1,789
2009	3	14,67	2,309
TOTAL	**23**	**17,08**	**3,382**
Dynamic nail			
2004	6	17,33	2,665
2005	3	18,67	2,309
2006	4	19,00	3.464
2007	5	19,20	3,033
2008	5	15,6	3,847
2009	-	-	-
TOTAL	**23**	**17,83**	**2,978**
Total femur (st + dy nail)			
2004	7	17,71	1,982
2005	3	18,67	2,309
2006	8	19,00	4,242
2007	10	19,99	3,00
2008	16	15,87	2,39
2009	3	14,67	2,31
TOTAL	**47**	**17,44**	**3,04**

Table 2. Average healing time – femur (static vs. dynamic nail). Diference (in weeks) in healing (static vs. dynamic nail) in not statisticaly significant (T test 0,897)

Year	Patients	Average number of healing (weeks)	Standard deviation (SD)
Static nail			
2004	-	-	-
2005	2	16,0	0
2006	4	13,5	13,43
2007	8	16,25	2,49
2008	36	13,28	4,38
2009	8	11,5	3,66
TOTAL	**58**	**13,55**	**2,89**
Dynamic nail			
2004	9	15,11	2,47
2005	6	15,33	3,27
2006	3	13,33	2,31
2007	3	18,67	4,62
2008	2	14,0	8,48
2009	1	12,0	0
TOTAL	**24**	**15,17**	**3,46**
Total femur (st + dy nail)			
2004	9	15,11	2,47
2005	8	15,5	2,60
2006	7	13,43	3,659
2007	11	16,91	3,48
2008	38	13,32	4,33
2009	9	11,56	3,26
TOTAL	**82**	**14,02**	**3,17**

Table 3. Average healing time – tibia (static vs. dynamic nail). Diference (in weeks) in healing (static vs. dynamic nail) is statisticaly significant (T test 2,227,p<0,05)

4. DISCUSSION

On the healing process of bone fractures affected by many factors, and the type of fracture, the volume of primary bone damage and its environment, the degree of stabilization of fractures and bone vascularization play a crucial role. Adequate blood supply is the basis of vitality and bone growth, resistance to infection and fracture healing abilities. Intramedullary nailing, to a greater or lesser degree, impairs vascular network of bones, and occurs AVN of inner part or the whole cortex. In this situation, periosteal arteries and paraosal circulation, i.e.. circulation of surrounding tissue, takes the lead role in the earliest period of healing of bone fractures, such as periosteal blood vessels pass through the cortex in the medullary cavity with the creation of reused medullary circulation network. In this way the centrifugal flow of blood supply in the fracture converts centripetal. On the other side intramedullary nail provides stability of fragments and contributes to the process of osteogenesis. The rigidity of the osteosynthesis is an important variable categories which can be a key factor in the early bone healing. It creates the conditions for rapid recovery of medullary circulation, which is an essential condition for the formation of endosteal callus. Biomechanical role of intramedullary nail to keep the bone fragments in good collaboration and

to prevent torsion and shear forces. It was felt, too, that at a given moment should ensure transmission of axial loads through the bone and the fracture phenomenon "dynamization", which allows micro movements at the point of fracture, assuming accelerating the process of osteogenesis, with the explanation that axially move fragments simultaneously reduces fracture hole, accelerates maturation of the fracture callus and bone remodeling. It is recommended that dynamization should be early, when the fibrous callus providing peace and stability fragments. Those recommendations for "dynamization" static to dynamic intramedullary osteosynthesis are still an enigma and a constant dilemma, especially if the "dynamization" necessary in any case in which optimal postoperative time, expressed in weeks. Some authors as a rule recommended by converting static to a dynamic form of intramedullary osteosynthesis of 10-16 weeks, while others consider this procedure unnecessary or even harmful. In our conditions, methods of intramedullary osteosynthesis is applied rarely and primarily was reserved for secondary osteosynthesis, after deferred wound or bone pseudoarthrosis and after primary stabilization boards on the principle interfragmentary compression, or in cases of conversion of external to internal osteosynthesis. (7). Possible reason for intramedullary nailing is not widely used in our conditions for primary stabilization of fractures of the femur and tibia is what it is, nevertheless, should provide adequate conditions for its performance, especially trained and trained operating team, with appropriate technical conditions in the operating room. This includes the appropriate extension operating table, mobile X-ray, implants for the femur and tibia of all lengths and diameters. If we go back to the analyzed period from 2004 until the second half of 2009, it is easy to determine that the prospective study of 2007 the number of surgically treated patients, primarily static intramedullary osteosynthesis, increased significantly. Thus, in 2007, made a total of 21 surgery, and at five surgeries static and dynamic intramedullary nailing of the femur, and eight surgeries static and three surgeries dynamic intramedullary osteosynthesis tibia. Already in 2008, has done 16 surgeries intramedullary nailing of the femur, and the static method 11:05 patients with dynamic method. Surgical procedures of tibia intramedullary osteosynthesis also experienced a significant increase, it is done 36 surgeries using static intramedullary osteosynthesis tibia and only 2 surgeries by the method of dynamic intramedullary osteosynthesis, and in patients in whom the interfragmentary hole was significantly larger than 0.2 mm, and was necessary "dynamization" after 10 weeks. The quality of work of operational teams, best seen in a small number of postoperative complications and the need for additional "dynamization". During the research period, there were only three non-unions, of which two of the femur and tibia 1, who were treated spongioplastics. Results of this study showed the justification of our suspicions of doctrinal enforcement "dynamization", and the need for additional hospitalization and surgery, removal of "static screw", for a period of 10-16 weeks. True, it is justified only in cases where there is a permanent diastasis bone fragments greater than 0.2 mm, and the conversion itself static in a dynamic fixation is rarely necessary in fractures of the femur. (8) In this case, the bone fragments are closing, but to be sufficient to instability, short extremities, a disorder of the rotation, with prolonged healing time and abundant callus with restless structure. In support of these conclusions of the study, Wu and Chen, where only half of segmental fractures of the femur done "dynamization" was successful, and have suggested the use of bone grafting, filling space between the bone fragments for faster healing. (9), Finally, we would say that the study of treatment of fractures of the femur and tibia using static and dynamic intramedullary osteosynthesis showed all the good effects of early stabilization of fractures in relation to morbidity and length of hospital stay. In this way, all the injured previously mobilized, shortened the length of hospitalization and reduced the complications associated with long immobilization.

5. CONCLUSIONS

Intramedullary nailing is a minimally invasive surgical procedure, without exposure fragments, which does not lead to major bleeding (100-200 mL of blood). For the application of intramedullary osteosynthesis is necessary to know the indications, bone biology and mechanical factors. Intramedullary nailing has a multi-purpose capabilities, usually is the definitive solution for the treatment of fractures of the femur and tibia, allows early mobilization of limb and early rehabilitation, all of which contributes to an earlier load and reliance on a limb, or the acceleration of bone healing. Typical indications for intramedullary osteosynthesis are diagonally and short oblique fractures of the middle third of the femur and tibia. In children is a contraindication to the application of intramedullary nail. Static intramedullary nailing unable movements between fragments which directly stimulates bone formation and formation of angiogenic minimal callus with sharp edges and a dense structure. Also static intramedullary osteosynthesis resolve the problem of stabilizing the fracture, limb shortening, rotation of bone fragments are the best recommendations for treatment are commuted fractures. Dynamic intramedullary osteosynthesis use force on the fracture, causing bone resorption and thus looseness implants due to mechanical instability, which creates large (stimulus) callus with vague contours and turbulent structure.

CONFLICT OF INTEREST: NONE DECLARED

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