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TREATMENT OF THE FEMORAL SHAFT FRACTURE BY SELF-DYNAMISABLE INTERNAL FIXATOR MITKOVIC

SUMMARY

The paper presents initial results in the application of a new method for the osteosynthesis of comminuted and unhealed femoral shaft fractures.

A self-dynamisable internal fixator Mitkovic was applied in 38 patients, out of which 23 patients with comminuted femur fractures and 15 patients with unhealed fractures.

The method of placement and results of the work and their estimation according to the modified system of the Karlstrom-Olerud method are presented. Good condition was registered in 17 patients, satisfactory in 9, approximately good in 6 patients, and poor condition in 6 patients. An average healing time for the femur fractures is 34 weeks, which depends on the type of the femur fracture and treatment of unhealed fractures.

The method of self-dynamisable internal fixator Mitkovic application provides complete stability of the fracture and makes spontaneous biological dynamization of the fracture possible. It does not damage the periosteal and medullary bone vascularization, which favors osteosynthesis and considerably contributes to osteogenesis.

Key words: **femoral shaft fracture, self-dynamisable internal fixator Mitkovic**

INTRODUCTION

Fast development of traffic, industry, agricultural mechanizations, sports and other activities consequently brought about the phenomenon of epidemics of traumatology. The injuries of the extremities are prevalent, the most frequent of which are fractures of the shin and thigh. The fracture of the femoral shaft occurs as a consequence of direct or indirect force effect.

The intensity of external force inducing a bone fracture is of crucial importance for the type and kind of fracture. It affects the degree of soft structures' damages in the vicinity of bones as well as degree of fragments' dislocation. The forces of great kinetic energy break bones into more fragments, dislocate them and considerably damage the adjacent soft tissue. Consequently, there are comminuted fractures with greater number of fragments, damages to vascular network of bone fragments, especially loose fragments, as well as disruption of periosteal circulation (1). This kind of fracture is hard to stabilize, and even if stability is attained by classic osteosynthetic devices (intramedullary nails, plates and screws), there is a great secondary damage to bone vascularization, so that the fracture usually does not heal or the process of osteogenesis is slow and rather long (2). The self-dynamisable internal fixator Mitkovic for femur is a new osteosynthetic device. Its basic characteristic and advantage is the application along the femoral shaft without deperiostation of fragments, by which the periosteal

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and periosseous vascularizations are not disrupted. The fixator preserves the biological bone milieu, so that this method is biological and non-compromising for soft tissues and vascularization. This procedure contributes to the process of osteogenesis which generally depends on numerous factors, the most important of which are: type of fracture, degree of primary damage to bone and its vicinity, degree of the fracture stabilization and vascularization of bones and adjacent soft tissues (3).

AIMS

The aim of the paper was to point to the application of the self-dynamisable internal fixator Mitkovic in the management of comminuted and unhealed fractures of femur, as well as to present the biological advantages of this method.

MATERIAL AND METHODS

The self-dynamisable internal fixator Mitkovic consists of the metal oval bar which is 10 mm in width and 15-30 cm in length. In the upper part of the bar there is an oval slot for the cortical screw by which the pin is fixed to the femur, and which plays the role of antirotation of the upper fragment. In the lower part, there is a groove of 2 cm in length which serves for the placement of the cortical screw with antirotational role in regard to the lower bone fragment. This screw is placed in the lower part of the groove along which the fixator slides downwards in the case of spontaneous dynamization and fragments' compression. An integral part of the self-dynamisable internal fixator is clamps which slide along the bar and serve for the placement of screws in different planes as well as for stabilization of fractures.

This retrospective study included 38 patients. In 23 patients (60%), the internal fixator was applied as a primary osteosynthetic device for stabilization of comminuted fracture of femur. In 15 patients (40%), the internal fixator was applied in the secondary surgical procedure:

- after turning the external fixation into internal one after the appearance of surface infection around pins of external fixator,
- after nonhealing of the fracture or after wound management, that is the management of the open fracture of femur,
- in the treatment of nonunions of femur, treated by some other method of osteosynthesis,
- after breaking of osteosynthetic material (intramedullary nail, plate) applied in the treatment of the femur fracture.

The internal fixator is placed along the femur, and then introduced upwards through the cut of 2-3 cm in length. In the proximal part, there is an upper part of the fixator and through the cut we place a cortical screw through the fixator hole. Then, we place internal fixator along the femoral shaft, do the fragments' reposition and then place the cortical screw along the groove in the lower part of the fixator. This screw is deliberately placed in the lower part of the groove to enable sliding of the pin along the vertical femur axis. This is how the sliding of the upper fragment starts, inducing compression of the lower part. The cortical screws are antirotational – they do not allow rotation of fragments but only vertical sliding. Along the bar, two clamps are placed for proximal and distal fragments. They are the screws' carriers that we place into two planes convergently so as to achieve stability of fragments at the site of fracture. The site of fracture should not be opened. Instead, we do the reposition of fragments stabilizing them by screws. Rarely, when the reposition of fragments is impossible or unsatisfactory, the fracture site should be opened with doing the open reduction of the fracture but without deperiostation of ends. Also, the interpositum should be taken out of the fracture site – usually, it is muscles.

RESULTS

The final results of the group examined were assessed by the modified method Karstrom-Olerud. We followed the subjective symptoms (pain, aggravation of walking, difficulty walking up the stairs, aggravation of condition after training sports, limitation of working ability) as well as the objective signs (skin condition, deformity, muscles' atrophy, leg length discrepancy, loss of movements in the hip and knee). Based on these parameters, a modified score system was introduced as well as five groups with different scores *(Figure 1)*.

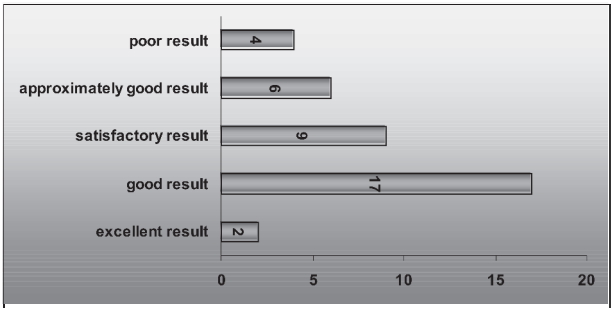

Figure 1. The final results of the examined group were assessed by the modified method Karstrom-Olerud

An excellent result at the end of the treatment was registered in 2 patients (5%). The examinees were young people with comminuted fractures of the femoral shaft. These injuries occurred in a car accident and were treated by internal fixator *(Figures 2-4)*.

Figure 2. Comminuted femoral shaft fracture

Figure 3. Fracture treated by self-dynamisable internal fixator Mitkovic

Figure 4. Fracture healing after 20 weeks

The consequences were not serious: mild atrophy of the thigh reduced the ability of running and training previous sports, reduced working ability related to jobs involving long walking, standing or some effort.

Good results were registered in 17 patients (45%) and satisfactory one in 9 patients (23%).

Approximately good results were registered in 6 examinees (16%), while poor results were noticed in 4 examinees (11%).

There is a great group of examinees with good and satisfactory results, in total 26 examinees (68%). The treatment of this group of patients was terminated without more serious consequences.

The most usual consequences typical of this group were: aggravation of walking, difficulty walking up and down the stairs, reduction of working ability with regard to hard and moderately hard physical jobs, shortening of the operated leg by 1-2 cm in 8 examinees, and hypertrophy of muscles by 1-2 cm in 17 examinees. All these consequences are tolerable, and did not change activities and habits of the examinees.

Serious consequences were noted in the group of examinees with approximately good as well as poor functional results. In this group, there were 10 patients (27%) with the following consequences:

• 2 patients suffered from chronic femoral osteomyelitis, which resulted from getting injured by shrapnels and gunshots. Initially, they were treated by the method of external fixation which was later replaced by internal fixation.

• in 6 patients, there was a reduction in the knee flexion – possible up to 80°, which was the result of long period of physical inactivity. As for these patients, the treatment started with plates and screws.

• in 4 examinees, there was a shortening of the extremity by more than 3%, which was the result of primary comminution and bone defect.

• In all patients, there was a marked hypertrophy as a consequence of long inactivity of the extremities.

DISCUSSION

In traumatology, there is a great choice of methods of treatment of the femoral shaft fractures. Depending on the fracture type and its comminution, the following can be applied: plates with screws, Küncher's nail, intramedullary nail, external fixator (4,5). At the Clinic of Orthopedics and Traumatology in Nis, the self-dynamisable internal fixator by Mitkovic is applied.

Numerous factors determine the process of osteogenesis and directly influence the course and outcome of fracture. Among them, the most important are: the type of fracture, stability of fixation and preserving the fracture site vascularization.

The internal fixator provides stability of fragments and contributes to the process of osteogenesis. It excludes the fracture from the lever chain and takes over the role of the fractured bone. It bridges the fracture focus and with its interponation into the bone itself makes a whole (6-9). The fixator rigidity is an important invariable category, which can be the key factor in early bone union. The internal fixator does not disrupt the intramedullary circulation, but preserves it providing condition for its recovery, which is an important precondition for the endosteal callus formation (3, 10).

The pressure between bone fragments plays an important role in the process of osteogenesis. Many authors have pointed that an optimal pressure in the healing process is 80N. Weaker compression leads to disappearance of bone, while greater compression brings about resorption of bones and nonunion (11, 12).

The biochemical role of internal fixator is:

• to keep fragments in proper relation, that is to provide the contention of fragments,

• to prevent torsion-axial forces which are quite unfavorable in the process of osteogenesis, since they constantly bring about damages to fibrous-cartilage callus structures, disrupting thus their transformation into bone structures.

Dynamization phenomenon induces transmission of axial loading over the bone fragments (4). The apparatus dynamization occurs spontaneously several weeks after the operation, when the micromovements appear at the fracture site, which substantially stimulates and speeds up the process of osteogenesis (1). Dynamization should start early when the fibrous callus has provided a rest of fragments, which in the case of femoral fractures occurs after 7-8 weeks (2, 11-13). After this period, doctors should insist on verticalization and walking with the use of crutches with gentle leaning on the operated leg.

The construction of internal fixator allows spontaneous dynamization. Then, the axial moving of fragments and decreasing of the fracture gap occur. With initial weight-bearing on the operated leg, the sliding of the whole apparatus with the upper bone fragments starts downwards, along the antirotational screw placed in the groove at the lower pole of internal fixator. The screws placed convergently in the fixator provide stability of fragments in all planes over the clamps. They are placed as far from the fracture site as possible so as to provide stability, to exclude the rotation-axial forces, and to provide the axial movement of fragments and compression in the bone focus.

An important factor in the process of osteogenesis is vascularization of bones (2, 14, 15). The degree of the bone vascular network damage affects the speed and kind of callus formation. The periosteal arterial and intramedullary circulation, that is the circulation around the adjacent soft tissue have the greatest role in the early period of osteogenesis. In comminuted fractures, the fracture focus loses both periosteal and medullary circulation.

Osteosynthetic material considerably disrupts bone vascularization. A plate with screws can seriously disrupt the periosteal circulation, while intramedullary fixation disrupts the bone medullary vascular network, inducing thus avascularity of the inner part of entire cortex (2, 5, 16, 17).

The internal fixator is ultimately sparing for the entire bone network. It is applied over the bone without deperiostation, so that it disrupts neither periosteal nor medullary circulation. It is placed in the way that it can skip the fracture site without opening, so that the primary hematoma does not enlarge. With the placement like this, there is a minimal disruption of the periosteal circulation, and therewith the process of osteogenesis depends only on primary, initial disruption occurring at the moment of trauma.

CONCLUSION

The self-dynamisable internal fixator Mitkovic is a new osteosynthetic device and a new biological method of the femoral shaft fracture fixation. The results are encouraging since this fixator provides conditions for a minimal surgical intervention. It also provides tridimensional stability of bones, as well as fragments' dynamization. In regard to the bone circulation network, it is ultimately sparing, providing thus conditions for the formation of great periosteal callus equally formed around the fracture site.

This fixator can be relatively easy and quickly applied, and the results obtained in this study justify its broad application in fixation of femoral shaft fractures and management of femoral pseudoarthrosis.

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LEČENJE PRELOMA DIJAFIZE FEMURA SAMODINAMIZIRAJUĆIM UNUTRAŠNJIM FIKSATOROM MITKOVIĆ

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SAŽETAK

U radu su prikazani rezultati primene nove metode za osteosintezu kominutivnih i nezaraslih preloma dijafize femura.

Primenili smo samodinamizirajući unutrašnji fiksator po Mitkoviću kod 38 bolesnika i to kod 23 bolesnika kao primarno osteosintetsko sredstvo za stabilizovanje kominutivnog preloma femura i kod 15 bolesnika u sekundarnom hirurškom postupku.

Prikazana metoda plasiranja samodinamizirajućeg unutrašnjeg fikastora je, kao i rezultati rada i njihova procena, po modifikovanom sistemu metode Karlstrom-Olerud. Dobro stanje utvrđeno je kod 17 bolesnika, zadovoljavajuće kod 9, približno

dobro stanje kod 6 bolesnika i slabo stanje kod 4. Prosečno vreme zarastanja teških kominutivnih i nezaraslih preloma dijafize femura iznosilo je 34 nedelje.

Metoda primene samodinamizirajućeg unutrašnjeg fiksatora daje potpunu stabilnost preloma i omogućuje spontanu-biološku dinamizaciju preloma. Ne oštećuje periostalnu i medularnu vaskularizaciju kostiju, što je velika prednost osteosinteze, a time znatno doprinosi razvoju osteogeneze.

Ključne reči: **prelom dijafize femura, samodinamizirajući unutrašnji fiksator Mitković**