

Review

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of the dissertation of Dr. Dimitar Stefanov Todorov on topic ***"Analysis of the results after minimally invasive fixation with angularly stable plates in distal femur fractures AO 33A / 33C"*** for awarding of Ph.D. degree.

I was commissioned to submit this review by order **No. RD26 1181 / 19.06.19** of the Director on UMHATEM "Pirogov".

Distal femur fractures continue to be a topical and often a difficult to solve issue of modern orthopedic traumatology.

Conventional non-surgical and surgical therapeutic approaches do not offer systematic and repeatable success. A high percentage of complications and poor results in the treatment of fractures in the distal end of the femur were until recently considered natural and inevitable.

The modern AO concept has brought clarity to the understanding of a number of statements, related to the biomechanics of distal femoral fractures, their systematics, indications for surgical treatment and its principles, the choice of operational access, their reposition and fixation.

The rigorous and massive enforcing of the AO doctrine in its modern form, substantially improved the practical results and limited the severe complications. The most significant breakthrough in this area is the development of the MIPO concept and introduction of osteosynthesis with angular stable plates.

The mass application, however, along with the undisputed successes, has led to a certain indiscretion and randomness in their routine use, resulting in disappointments.

Failure to comply with several factors such as: different bone quality, variety in motor needs in individual patients and, in particular, diverse fractural morphology, naturally led to the emergence of specific problems most commonly associated with the reliability of fixation and achieving solid bone healing.

Logically, the cases of insufficiency and even breakdown of osteosynthesis (debricolage), incorrect healing and non-healing, are as high as 20% in some

published series. This has cooled down the initial enthusiasm and made some surgeons asking themselves if MIPO is really a method of choice for treatment of distal femur fractures. It became apparent that implanting a lateral locking does not guarantee a favorable result and is not a panacea. As a way out of the situation, surgeons have attempted both mechanical reinforcement of fixation (most often by additional implants) as well as biological stimulation of the bone healing with different grafting techniques.

Anyone resorting to MIPO with a lateral locking plate is inevitable facing the following concerns:

- To what extent does the lateral locking plate create optimal conditions for callus-formation of the meta-diaphyseal transition?
- Which cases of metaphyseal comminution or bone insufficiency are applicable for augmentation and how exactly to perform it?

It is precisely these topical issues that are presented in the scientific work of Dr. Dimitar Todorov, entitled ***"Analysis of the results after minimally invasive fixation with angularly stable plates in distal femur fractures AO 33A / 33C"***.

The dissertation is in volume of 134 pages and is structured in a typical way, namely - literature review, material and method, results and complications, discussion, closure and conclusions. The stated goal of fulfilling a retrospective analysis of outcomes and complications in patients with distal femur fractures type AO / OTA A and C, fixed with locking plates and differentiating the risk factors leading to problems with the consolidation of the FDF - is sufficiently clear. Additionally, the author sets himself a goal to make recommendations for optimizing the surgery method through biomechanical laboratory testing. In order to achieve the set goals, the author formulates 4 scientific tasks. They are logically justified, stem from the purpose and are practically feasible.

The thesis paper begins with a brief introductory chapter reflecting Dr. Todorov's motives to dwell on this subject, as well as the relevance of the scientific issue.

Chapter 1 "Literature Review" covers the author's classic and contemporary publications on the topic of treating distal femur fractures. The scope of the review is exhaustive, and the analysis of the sources is correct and critical.

Chapter 2 presents the clinical series of patients treated according to specific healing algorithm. Selection criteria are clearly stated as well as the indications for the administration of the LISS plate. The operating technique is described and illustrated in detail.

The cluster is comprised of 97 patients with 100 distal femur fractures, surgically treated with OS with a lateral-locking plate and followed up for a period of 5 years (January 2013 - December 2017). All of them meet the set criteria and have passed through the Orthopedic Traumatology Clinics of UMHATEM “N. I. Pirogov”. 54 patients (57 fractures) were followed up to consolidation to the end of the recovery period when the consequences of fracture and treatment are considered definitive.

Chapter 2 also describes the experimental study that was performed by the author at AO Research Institute - Davos. The essence of the experiment is a non-destructive testing of distal femur models with simulated fracture with lateral fixation locking plate. The models are divided into three groups - fixed only by lateral plate, lateral plate + medial plate augmentation, lateral plate + augmentation with intramedullary graft.

The experimental work is directly related to the problems of the study.

The same section (Material and Methods) describes the documentation used and the statistical methods applied that create the conditions for correctness and reliability of the scientific work.

In **Chapter 3**, the author presents the results and complications. After analyzing the mechanism of the trauma, the accompanying injuries and the duration of the treatment, the author reviews X-ray and clinical outcomes of MIPO fixation with a laterally inserted locking plate. The fact that comparable implants from 11 manufacturers that had similar characteristics were used for osteosynthesis and placed by 23 surgeons, gives a realistic observation on current practice and does not reduce the weight of the presented results and drawn conclusions.

There is a statistically significant relationship between the frequency of problematic fixation and delayed healing, on the one hand, and energy of the trauma and frequency of accompanying injuries, on the other.

The distribution of results according to the objective rating scale, The Schatzker score, is as follows: excellent results in 12 (21%) patients, good 15 (26%), satisfactory 8 (14%) and bad 22 (39%). This data is to a large extent also confirmed by the application of the subjective scale for evaluation of knee function - Lysholm score.

In this regard, the author's ability to be precise and critical in his analysis of both unsuccessful results and occurrence of complications is evident.

Chapter 3 also presents the biomechanical data collected throughout the laboratory experiment. It demonstrates that the longitudinal dislocation of the axial load fragments differs significantly between the three fixing techniques for both working lengths. Greatest deformation is detected upon fixation with the LCP followed by the LCP + IM graft and fixation with 2 LCP.

These findings have significant practical implications.

Chapter 4, Discussion, is the essence of this dissertation as it reviews all aspects of modern treatment of distal femur fractures, the healing philosophy that built the author's behavior, the benefits and the disadvantages of existing approaches and means of fixation.

There is an in-depth analysis of the importance and the favorable reflection of bone augmentation as an important factor in improving prognosis in fragmentation and the presence of other risk factors.

The conclusions are especially valuable as they are based not only on longstanding clinical results achieved at a major trauma center (UMHATEM Pirogov), but are also based on a meticulously performed biomechanical experiment in a reputable laboratory.

All questions raised about the biological response to bone (callus formation) under conditions of varying degrees of rigidity, in fact affect the most up-to-date, or perhaps, eternally up-to-date topic about the balance between biology and mechanics, which is the basis of everyone's resolution of a clinical issue in fracture surgery.

Dr. Todorov's work ends with 3 conclusions, in which he presents the essence of the above scientific work concisely but accurately.

The conclusions are tied to the assigned tasks and goals. The objectively reflect the results of the study and are of both theoretical and practical value.

I have some small, mostly technical, remarks that do not discredit the quality of work in any way. As a more significant note, I would recommend more comprehensive formulation of the second and third conclusions of the dissertation.

The author presents 8 dissertation titles, 7 of which are foreign language publications in reputable sources. Dr. Todorov is the first author in 7 of the publications.

Let me emphasize the following major contributions from the author:

1. The method of minimally invasive fixation with angularly stable plates at distal femur fractures was applied to a sufficiently large contingent of patients.
2. Method-specific capabilities and disadvantages have been sought and proven.
3. A detailed statistical analysis is conducted to differentiate the various factors leading to poor treatment outcomes as well as complications with the consolidation of fractures.
4. The advantages of the augmentation technique have been experimentally proven for fixation of distal femur fractures.
5. Modern indications for modification of osteosynthesis with angular plates in distal femur fractures have been described in detail and recommended.

CONCLUSION. The dissertation submitted to me for review is a complete and comprehensive research work. Thesis deals with a current topic, it is structured properly and proportionately, contains a number of innovative elements, includes sufficient contingent of patients, objectively and correctly presents the results and ends with useful and practical theoretical conclusions for contemporary traumatology. The dissertation fulfills the lawful criteria, the regulations for its application and the corresponding rules of UMHATEM "N.I.Pirogov" for the acquisition of a Ph.D. degree.

On the basis of the above, I suggest that the scientific jury should award Dr. Dimitar Stefanov Todorov the educational and scientific Ph.D. degree in Orthopedics and Traumatology.

29 October 2019

Sofia

Respectfully,

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