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Mini Review

Biomechanical assessment of cannulated nails for the treatment of proximal femur fractures

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Abstract

This article focuses on cannulated femoral nails, a type of surgical implant used in orthopaedics and traumatology. Femoral nails are used in medical treatment for osteosynthesis, or the treatment of various types of complicated fractures. Femur fractures are a common occurrence. The article looks into cases where a nail has been implanted in the body. compared to cases where the bone has already healed, the proximal part of the femur for a short time (with the fracture still not healed). The examined fractures are classified as AO 31B3 and AO 32A3 by the AO. The primary focus is on strength-deformation analysis using the finite element method (FEM), which allows the behaviour of the femur implant system to be determined. To compare, FEM analysis was used.

Keywords: Proximal femoral nailing; osteosynthesis; numerical simulation; traumatology; FEM analysis; biomechanics; short reconstructive nails

INTRODUCTION

Nails are used in medicine to treat various types of limb fractures. Femoral nails are used to treat proximal and distal femur fractures. This article examines the nails used to treat proximal femoral fractures in the vicinity of the pelvis. It also emphasises the importance of using short reconstructive nails in the treatment of specific proximal femur fractures. Medin (Nové Mesto na Morave, Czech Republic) and Tantum (Neumunster, Germany) produce the nails under scrutiny.

It is based on previous theoretical and practical research on the proximal femur. The fractures in these areas are classified as fracture mediocervicalis femoris AO 31B3 and fracture subtrochanteric femoris AO 32A3. These are the most common long bone fractures and human traumas, and they pose the greatest risk to the elderly population.The vast majority of patients with these fractures are over the age of 50, and women are affected 2 times -3 times more frequently than men. For these reasons, conducting stress-deformation analyses and determining the suitability of femoral nails for clinical treatment is beneficial. The femur is the largest and heaviest bone in the human body The proximal part of the femur is made up primarily of the almost spherical femoral head (caput femoris), which sits within the pelvic acetabulum; the femoral neck (collum femoris), which forms the neck-shaft angle (collodiaphyseal angle) with the main axial length of the femur (usually 135°); and the eminence The femoral neck is approximately anteverted to the frontal anatomical plane. Proximal Femoral Fracture (PFF) is one of the most common types of long bone fracture, and it is especially dangerous in the elderly. We know that PFFs account for a significant portion of hospitalizations and potential complications in trauma cases.

More precise classifications of these fractures have been developed, allowing for more practical descriptions and the sharing of clinical experiences among different treatment centres. Evan developed one of the most wellknown classifications of trochanteric fractures. Numerous authors have written about femoral neck fractures. Garden provides one of the most widely used classifications, dividing fractures into four grades: I. incomplete, II. complete but nondisplaced, III. complete and partially displaced, and IV. complete and fully displaced. The international AO/OTA system, developed by the Swiss AO and the OTA, is another classification system for PFFs (and other fractures) (Orthopedic Trauma Association). This system assigns fracture types using numbers and letters. PFFs are identified by numbers beginning with 31. Numerous authors have written about femoral neck fractures. Garden, for example, divides fractures into four grades:

- Incomplete.
- Complete but nondisplaced.
- Complete and partially displaced.
- Complete and fully displaced.

The international AO/OTA system, developed by the Swiss AO (Arbeitsgemeinschaft für Osteosynthesefragen) and the OTA, is another classification system for PFFs (and other fractures) (Orthopedic Trauma Association). This system assigns fracture types using numbers and letters. PFFs are identified by numbers ranging from 31 to 100. PFFs are denoted by numbers beginning with 31[1-6]. Each of these types of proximal femoral fracture necessitates a unique treatment strategy, with its own set of potential complications and controversies regarding optimal management [7-10].

RESULT

The values shown and express the evaluated and maximum HMH stress values in MPa (occurring at the locations with stress concentrators, i.e., notches). Equation is commonly used to calculate the equivalent HMH stress. Extreme stress levels occur in very small areas. The analysis also takes into account the so-called evaluated stress values that occur near the maximum. In general, the stresses that occur in nail systems are significantly lower.

CONCLUSION

This article discusses the anatomy, physiology, and treatment of AO 31B3 and AO 32A3 proximal femur fractures. Ten cannulated nails manufactured by Medin a.s. and Tantum were biomechanically evaluated. The finite element analyses of femurs with cannulated nails with or without fractures show that the safety levels for the elasticity limit state are very high even at extreme stress values. Stresses calculated using variable collo-diaphyseal angles of 120 to 135 result in safety values ranging from 6.50 to 14.97. This indicates that the implants are appropriate for patient treatment. It is important to note, however, that the actual application of nails varies from patient to patient (due to the collo-diaphyseal angle of the femur, bone material properties, and so on). These factors have a significant impact on the transfer of force from the body (the bone) to the implant. As a result, because each case is highly individual, the values may differ significantly between patients.

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