Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Biomechanical comparison of fatigue and load-bearing performance of elastic stable intramedullary nailing

Berger, Leopold, leopold.berger@tuwien.ac.at; Kolbitsch, Andreas, Vienna University of Technology, Austria; Fischerauer, Stefan; Castellani, Christoph; Weinberg, Annelie, Medical University of Graz, Austria

ABSTRACT

Purpose: Elastic stable intramedullary nailing (ESIN) is a very common method for the treatment of pediatric long bone fractures. Because of the fact that ESIN nails offer the chance of micromotion during the healing process, this method is beneficial in comparison to rigid bone fixation and stimulates the formation of a callus [1]. The time between the incident of the fracture and complete generation of the stabilizing callus seems to be a critical phase for the implants' load-bearing. Torsional and axial stability has to be ensured by the ESIN implant during this phase.

Methods: Because of the studies aim of monitoring the period until the formation of a callus, ovine cadaver tibiae (3–4 months old) were implanted regarding clinical standards after osteotomy at the mid diaphyseal region. Four different combinations of locking systems and ESIN implants were observed during this study. Synthes TEN Titanium with endcaps (n = 7), Hofer Medical HSNesin Titanium unlocked (n = 8), Hofer Medical STEN Steel with eye and 3-mm screw (n = 8), and Hofer Medical HSNesin Titanium with plug and 3mm screw (n = 8) were used. All nails were 3 mm in diameter. Cyclic mechanical loading was applied using a commercial uniaxial testing device (1710DLL-5KN, Dynamess, Germany), and a pneumatic torsion testing module which was constructed by one of the authors. This device is able to apply axial load and torque to the specimen simultaneously.

Results: Juvenile ovine bones were used in this study to generate similar conditions as in pediatric long bones. All samples failed by a closure of the initial osteotomy gap of 10 mm. The results of biomechanical tests showed significantly higher load bearing capability with each interlocking system than with the unlocked ESIN. (1000 N max. compared with 200 N). The unlocked system and the endcap ESIN failed very abrupt, whereas the 3-mm plug and the steel system failed slowly. Above all, the 3-mm plug with steel ESIN experienced gap closure without any damage to plugs or screws, which led to a distal penetration of the diaphysis by the nails.

Conclusions: Interlocking systems seem to be beneficial for stability of ESIN nailing under cyclic and simultaneous axial and torsional loading. The strongest combinations in this study were Hofer steel nails and Hofer plugs with 3-mm locking screws.

Significance: Different combinations of ESIN nails and interlocking systems show diverse load bearing behaviors. Desirable characteristics of nonabrupt failure during the nails loading and maximal strength of interlocking systems could be established.

REFERENCE

[1] Bishop, N.E., van Rhijn, M., Tami, I., Corveleijn, R., Schneider, E., Ito, K. Shear does not necessarily inhibit bone healing. *Clinical Orthopaedics and Related Research.* 443.