ESIN IN OVINE TIBIA – A BIOMECHANICAL ANALYSIS UNDER AXIAL LOAD AND TORSION

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Introduction

Elastic Stable intramedullary Nailing (ESIN) is a common used method to treat paediatric long-bone fractures. But there occurs a stability problem treating complex fractures or heavier children (over 40kg). We performed in vitro tests to gain knowledge about the biomechanical behaviour of the bone-implant-system, the maximal bearable load with and without different end caps.

Methods

ESIN nails (3mm diameter) were implanted in ovine tibiae from the butcher, which are very well fitting in size to a child´s long-bone. We performed 6 different groups m (8 samples in each group); one without end caps, 3 groups with common used end caps from different suppliers, one group with end caps designed for heavier children and one with end caps for really heavy ones.

After the implantation process in the middle of the tibia a 10mm fracture gap was performed and the distal and the proximal were potted in a cube of bone cement in order to allow optimal fixation in the testing machine.

We performed a 5000 cycle test with the load of 100 N combined with a torsion force of 0,2 Nm. Afterwards the load was increased 200 N stepwise for 1000 cycles until the fracture gap was closed or the nails or end caps failed. Before and after the test X-ray and light microscope pictures were taken for documentation. During the whole measurement the way shifting in axial direction, the rotation of distal and proximal fragment and the complete movement auf the proximal part were recorded.

Results

Very surprising was the bearable load of ESIN nails without end caps. We expected that these specimens will reach a functional failure much earlier. In the behaviour of the common used ESIN nails with end caps, there is a big different between the suppliers. There are two failure modes. In one group the end caps are pushed out completely if the critical bearing load is exceeded, whereas in the two other groups the end caps are saving the nails into the bone. The end caps are moving a little bit, but it needs an about 400 N higher load to lead to a clinical failure.

The end caps designed for heavier children are able to bear higher loads than the other ones. So there correct design is approved.

Discussion

The end caps have a great influence on the maximal bearable load of the ESIN nail and end cap system. The performance is different between the suppliers. The end caps for heavier children are legitimated.

With this result with already commonly used ESINs we are able to develop design requirements for new materials in ESIN surgery. The design of biodegradable ESIN materials is the next step in our research.

References

This is a new developed testing routine concerning ESIN nails with and without end caps combined with ovine tibiae