IMPLANT FIXATION ENHANCED BY INTERMITTENT PARATHYROID HORMONE TREATMENT

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Introduction
The fixation of an orthopedic implant depends in part on growth of bone at the surface of the implant. Current methods of enhancing bony apposition include bioactive coats and surface texturing. Parathyroid hormone (PTH) is a major hormonal regulator of calcium homeostasis. Intermittently administered PTH has an anabolic effect on the skeletal metabolism. The present study evaluates the possibility of enhancing the bone–implant fixation of stainless steel screws by PTH (1-34) administration.

Materials and Methods
The threaded part of the stainless steel screws was 1.7 mm in diameter (thread M17) and 3mm long. The head of the screw was triangular in order to fit the chuck used for torque measurement. The screws also had a hole in the triangular head in order to connect to a specially constructed device for pull-out measurement. Twenty-eight rats received one screw in either just one (n=8) or in both (n=20) proximal tibia. One was used for removal torque (left) and the other (right) for pull-out strength. After screw implantation, the rats were randomly divided in two groups. One group (n=14) was injected subcutaneously with human PTH (1-34) at a dose of 60 µg/kg BW/day. The second group (n=14) was injected with vehicle only. After four weeks the rats were killed and maximum torque value was recorded from the screw in the left tibia. The pullout strength was measured at the right tibia as the peak force when the screw loosened from bone. All specimens were then prepared for decalcified histology with sections parallel to the long axis of the screw hole. Approval of the Institutional Review Board was obtained before the study was started.

Results
The removal torque in the PTH treated group was three times higher than in the controls (p=0.001) and pullout strength doubled (p=0.002). PTH treated implants revealed mean removal torque values of 3.5 Ncm (SD 0.15) and the untreated specimens showed mean removal torque values of 1.1 Ncm (SD 0.02) (Figure 1). The mean pull-out strength of PTH treated specimens was 145 N (SD 42), whereas the untreated specimens showed mean pullout strength of 66 N (SD 14) (Figure 1). Histologically, both groups showed areas of soft tissue at the bone implant interface. These areas appeared less in the PTH group, which also revealed a higher density of trabecular bone around the implant.

Discussion
The results indicate that intermittent PTH treatment might be useful to enhance early fixation of orthopedic implants. Because the torque remained high with continued twisting, and thus represented friction 1, it appears that the considerable torque that developed with PTH-treatment, was the result of a larger proportion of the screw surface having direct contact with bone. In contrast to the torsion test, the results of the pull-out test is mainly dependent on the bone surrounding the implant and less on the properties of the interface, because the threads constitute an efficient load transfer mechanism. In consequence the bone close to the implant was splintered and fractured in the pull-out test.

To our knowledge, implant fixation after PTH administration has not been studied before. The action of PTH in the present study and the finding of a higher trabecular density in a previous study 2 complies with the concept that intermittent PTH treatment acts by enhancing recruitment and proliferation of osteoprogenitor cells 3. The use of intermittent PTH treatment for osseointegration and fracture healing implies only a short treatment. This would avoid the risks of adverse effects associated with chronic medication.

References

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Figure 1
Removal torque in Ncm (A) and pull-out strength in Newton (B) for screw implants after daily PTH (60µg PTH/kg/d) or vehicle treatment for 4 weeks.