**SURFACE BOUND BISPHOSPHONATE ENHANCES SCREW FIXATION UP TO 8 WEEKS AFTER INSERTION**

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Introduction

It has already been shown that the pull-out force of stainless steel (SS) screws inserted in bone increases with systemic or local treatment with bisphosphonates [1]. Furthermore, SS screws coated with a thin layer of cross-linked fibrinogen and bisphosphonates also showed better fixation at 2 weeks [2]. This study examines this concept further, by measuring the development of fixation over time in trabecular and cortical bone.

Materials and Methods

**Bisphosphonate coating procedure.** Screws were cleaned and coated with 3-amino-propyltriethoxysilane, H$_2$(N(CH$_2$)$_3$Si(OC$_3$H$_7$)$_3$, (APTES, from ABCR Germany). The APTES coated screws were incubated in glutardialdehyde, and ten layers of fibrinogen were prepared on top of this. Two N-bisphosphonates were then bound to the fibrinogen-coated surfaces. Pamidronat disodium (Aredia®, 1 mg/ml in dest. water, Novartis, Sweden) was immobilized to the fibrinogen multilayer using the EDC/NHS coupling technique, and finally Ibbondronat (Bondronate®, 50 μl/ml in dest. water, Novartis, Sweden) was adsorbed on top. A null ellipsometer (Auto-Ell III, Rudolph Research, USA) was programmed for measurements on Si in air and the layer thickness measured (n≥5) in trabecular and cortical bone.

**Animal experiments.** A screw was inserted in trabecular bone in 98 male Sprague-Dawley (SD) rats, with mean body weight of 383 grams (range:350-441 grams). 5 rats were excluded due to failed operation and 32 animals were excluded due to confusion of rat ID or failure during analysis. In cortical bone screws were inserted in 105 SD rats, with a mean body weight of 390 grams (range:335-457 grams). One rat was excluded due to failed operation and 8 rats excluded due to failed analysis. The study was approved by the regional ethics board.

Result

There was a gradual improvement of fixation over time (Figure a and b) in trabecular and cortical bone. (regression p = 0.0001 for both; Figure). The bisphosphonate-coated screws showed better fixation than surface attachment. The increasing effect of the bisphosphonate with time therefore suggests that the bisphosphonate is retained in the surrounding bone structure, with a positive effect on its gradual adaption to the implant. No difference in the effect of treatment between trabecular and cortical bone was observed.

**Discussion**

Because of longitudinal bone growth, the screw inserted in trabecular bone will be positioned more distal to the physis with time, and hence surrounded by more cortical bone. That explains a part of the increase in pull-out force for the control screws inserted in trabecular bone, but not in cortical bone. Pull-out strength is dependent on bone quality at a certain distance from the screw, rather than surface attachment. The increasing effect of the bisphosphonate with time therefore suggests that the bisphosphonate is retained in the surrounding bone structure, with a positive effect on its gradual adaption to the implant. No difference in the effect of treatment between trabecular and cortical bone was observed.

**Surface immobilization of bisphosphonates improves the mechanical fixation of SS screws in rat tibia in terms of an increased pull-out force and energy. The effect increases over time.**

References


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