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Deformation stimulates bone – feasibility of an innovative surgical approach for *in-vivo* measurements of bone deformation

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Introduction: Bone deformation stimulates bone and is crucial for astronauts during space flight. Knowledge on bone deformation during activities could help improve astronaut training and osteoporosis treatment. A new method for *in vivo* bone deformation measurements was developed by the authors, offering technical advantages over previous approaches. Using motion capturing, it computes deformation from the relative displacement between reflective markers attached to the bone via screws. This technique is less invasive than strain gauges attached to the bone surface. However, feasibility of the approach had been almost unanimously rejected by colleagues and experts in the up-run for this study. Their main concerns were pain and infection.

Materials and Methods: Aim of the study was to evaluate feasibility regarding surgical technique, pain, risk of infection, bleeding and wound healing in five healthy subjects between 26 and 50 years of age (mean 37.2 years +/- 7.8). Three titanium screws were inserted 3 mm into the cortical bone of the tibia in local anesthesia fig. 1). Screws were in place for 6 to 8 hours, during which a variety of exercises were performed including running, jumping, stairs and squats. A pain questionnaire was used to assess pain levels during experiments. The visual analog scale ranging from 0 to 10 and open questions were employed. Bone scans were taken to locate and evaluate screw holes. Opening of the medulla would aggravate outcomes in case of infection.

Results: Feasibility was good and screws remained in place throughout experiments. The average pain level throughout the experiment day was 0. Screw implantation and explantation can be done in local anesthesia, and a large number of exercises can be performed with only a minimum of pain medication. PQCT-images showed the bone medulla was not opened in any case. In the first subject, bleeding caused interruptions. This problem was controlled through size-reduction of skin incisions, application of ‘steri strips’ and extensive cauterization. Wound healing was without complications in all subjects.

Discussion: The new optical method is feasible from a surgical point of view with astoundingly low levels of pain and discomfort. The threat of infection was minimized. Bleeding was efficiently reduced and wound healing was without complications. The new method is feasible from a surgical point of view and opens a variety of options for new clinical and scientific applications.