INTRODUCTION: Cannulated screws, along with guide wires, are commonly used for a variety of orthopedic indications. Typically they are used for fractures in cancellous regions. Breakage or bending deformation of the guide wire is a clinical concern. Therefore, it would be advantageous to use Co-Cr alloys such as MP35N and L605 in these applications as the occurrence of breakages and bendings would be reduced. If Co-Cr alloy guidewires are to be used with 316L stainless steel cannulated screws, it is important to rule out galvanic or crevice corrosion. Therefore, we designed an experiment to determine if galvanic or crevice corrosion occurred in the in vivo environment. Implant devices were designed to replicate a clinical situation where dissimilar metals could potentially form a galvanic couple.

METHODS: Custom-made implants were developed (Fig 1). In all cases the screw was 316L stainless steel while the guide wire (centre component in fig 1) was interchanged between 316L (control), MP35N and L605. The cannulated part of the screw had a conical shape. This construct was considered to mimic a cannulated screw with a broken guide wire remaining in situ.

Fig 1: The design of the implants to test crevice and/or galvanic corrosion. Central region (red) represents the test guidewire. Samples were implanted into the cancellous bone of the distal femur and the proximal tibia of Swiss mountain sheep for both 1 and 6 months. Post mortem samples were analyzed using Scanning Electron Microscopy (SEM; n = 8 per group) and histological analysis (n = 8 per group). Both SEM and histological analysis was performed at multiple areas along the length of the screw to determine if the crevice size had an effect on the cellular infiltration and corrosion. A non-parametric analysis for repeated measures (Friedman test) was used to compare histological score data for each parameter. Post hoc analysis was performed using a Wilcoxon test. Significant differences were reported where p ≤ 0.05.

RESULTS: From SEM analysis of the screws and guide wires, no visible signs of corrosion were observed at either time point or for either group. However, there were mechanical manufacturing marks and tissue residues after enzymatic cleaning were visible on all samples.

The 1 month time-point, no differences were seen in all other parameters analyzed at the 6 month time period.

Fig 2: Images taken of a 316L guide wire after 1 month implantation at position 3. Legend: A tissue, B insertion marks, C machining marks, D protrusions. At the 1 month time-point, no significant difference was detected between any of the materials for tissue response in front of the window or in the gap. In brief, no adverse cellular response was observed in any test group, however little or no bone had formed in the gap. For the 6 month time period, the 316L stainless steel pin and screw combination had less bone tissue in the gap in the central region, but this was not significant (p=0.086). Similar to the 1 month point, no differences were seen in all other parameters analyzed at the 6 month time period.

REFERENCES:

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Fig 3: A) 316L guide wire after 1 month implantation showing limited bone re-growth into the drill hole created for placement of the implant; B) L605 Co-Cr alloy guide wire after 6 month implantation showing bone formation in front of the window and in the gap.