**Sublaminar wires made with Dyneema Purity® fiber for fusionless scoliosis correction**

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**INTRODUCTION**

Surgical correction of spinal deformities in growing children is carried out with or without fusion of the vertebrae. Sublaminar wiring, first described by Luque, allows longitudinal growth continuation of the non-fused spine after correction of the deformity. Neurological complications and wire breakage are the main clinical problems during the introduction and removal of currently used metal sublaminar wires.

In this pilot study posterior hybrid instrumentation with the use of medical-grade UHMWPE sublaminar wires (made with Dyneema Purity® fiber) was assessed in an ovine model. It was hypothesized that it provides a safer replacement for current techniques in which titanium sublaminar wires are used, while also providing better handling properties and sufficient stability of the non-fused spinal column with preservation of growth.

**METHODS**

Six skeletally immature Tesselaar sheep were used in this study. Each surgery was performed under general anesthesia and strict aseptic conditions. Pain medication was administered and standard cardio-pulmonary parameters were monitored. Antibiotics were administered preoperatively and continued for 24 hours. Postoperative pain management and wound care were provided until the animals were allowed to return to activities ad libitum.

With the animal in prone position a midline posterior incision was made. Under fluoroscopy two pedicle screws were placed at lumbar level. From the four above situated vertebrae, the interpedicular ligaments and the ligamentum flavum were removed and the laminae were exposed. These four consecutive laminae were attached to two titanium rods using 3 mm wide UHMWPE constrictions (made with Dyneema Purity® fiber) on the left side and 5 mm wide UHMWPE-constrictions on the right side (Figure 1a). The sublaminar wires were fixed with a modified double loop sliding knot and tightened with a tensioning device. This provided temporary tension and allowed retensioning of each wire before permanent knotting. Final fluoroscopy images were acquired to verify proper positioning of the system before closing the wound. As a control, titanium sublaminar wires (Atlas™, Medtronic) were applied in one animal. All animal procedures were approved by the Animal Ethical Committee of Maastricht University (DEC 2009-128).

The animals were sacrificed after an average postoperative period of 15 weeks. The spines of the sheep were excised en bloc. Radiographs and CT-scans were acquired. Preoperative and postoperative radiographs were compared to analyze growth. The vertebrae were dissected and fixated in formaldehyde. Cryogenic and plastic sections were obtained for macroscopic and histological evaluation.

**RESULTS**

Constructions made with Dyneema Purity® fiber showed good handling and tensioning properties. No neurological complications occurred during the study. Post mortem macroscopic analysis showed that none of the 3 or 5 mm knots loosened. CT-scans and radiographs confirmed the preserved stability of the instrumentation. Radiographs confirmed growth of the operated segment in all animals. Even though no decortication was performed, several bone bridges with fused levels were seen on CT-scans. Cryogenic sections confirmed the bone and cartilage remodeling around the rods and wires at the posterior side of the lamina. One animal developed a wire fistula and one animal died the first postoperative day due to anesthesia complications.

Histological sections showed that the wires were tightly looped around the lamina. The spinal cord was not or minimally compressed by the different wires and no damage to the dura was observed (Figure 1b). The construction with a width of 5 mm occupied more space than the 3 mm construction in the vertebral foramen and both these UHMWPE wires occupied more space than the titanium wires. However, none of the sheep showed any signs of neural damage.

Differences in bone reaction between Dyneema Purity® fiber and titanium were found. The plastic sections showed that the wires of both materials moved into the bone of the lamina to some extent.

**DISCUSSION**

This pilot animal study shows that the UHMWPE laminar wires made with Dyneema Purity® fiber have good handling and tensioning properties and provide sufficient stability in fusionless spinal instrumentation, while allowing growth. The sheep model appeared to be a feasible spinal study model, without any neurological complications. Analysis of CT-scans showed several bone bridges with fused vertebrae. This led to some restrictions in this model since it might affect growth and thereby hamper the evaluation of the UHMWPE-fiber properties for fusionless spinal instrumentation.

Histological analyses showed some migration of the wires into the bone of the spinal canal for both titanium wires and wires made with Dyneema Purity® fiber. An explanation for this migration can be the force that the wires exert on the laminae in combination with the general growth of the vertebrae in all directions. Since there were no signs of inflammatory processes, it is assumed that the migration is no direct reaction to the material. Also, ingrowth of bone in between the UHMWPE constructions was noticed. The degree of migration and ingrowth was regarded not to be harmful for the animal, the stability of the instrumentation or for longitudinal growth. Follow-up studies are focusing on a true animal scoliosis model to test the herein described instrumentation under the circumstances present in scoliosis patients.

**SIGNIFICANCE**

Scoliosis is a severe three dimensional spinal disorder, mostly affecting children. Developing and optimizing new techniques to correct spinal deformities to minimize patient discomfort and allow growth is of high clinical relevance.

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