ABSTRACT
Early onset scoliosis (EOS) is a deformity of the spine occurring in children before the age of 5. Surgical treatment with metal rods and wires to correct the spine curvature is considered for patients with severe or rapidly progressing deformities. Treatment in this patient group is especially difficult due to the incomplete longitudinal spinal growth. Any treatment that would restrict growth of the spine in this patient group may cause severe pulmonary problems, due to hampered thoracic cage development. For this reason, EOS patients undergo repeated lengthening procedures at 6-9 month intervals with so-called growing rods.

A growth guidance system for treatment of EOS, which aims to eliminate the need for surgical lengthening procedures, is currently under development at the Maastricht University Medical Centre (MUMC+). The proposed constructs consists of two metal rods that are placed along the spine and fixed at the curvature center of the spine using pedicle screws to prevent rod migration. Ultra high molecular weight polyethylene (UHMWPE) sub laminar wires made with Dyneema Purity® fibers at the proximal and distal ends are used to fix the vertebrae to the rods. Because of its inherent low friction properties, the UHMWPE wires can slide along the rods enabling growth. In this project, we aim at further developing and optimizing this new approach.

The first goal was to develop a spinal implant test setup that is needed to examine the effect of two different sublaminar wire attachment techniques (a diagonal and a square-shaped attachment) and addition of a sliding rod-connection ('crosslink') to the stiffness of the construct. A second goal was to develop a finite element (FE) model of this spinal implant test setup and to validate this with the results from the experiments. A third goal was to design a patient-specific, 'locking crosslink' based on a CT scan of the patient’s spine using 3-D printing techniques. This crosslink, which aims to prevent rod migration, will be fixed at the curvature center using pedicle screws. However, pedicle screw placement may be difficult in scoliosis patients due to distorted pedicle anatomy that is commonly encountered. Therefore, the patient-specific implant will also function as a drill guide to facilitate pedicle screw placement. Testing of the clinical feasibility of the approach will be performed by applying it to patient data.

The spinal implant test setup was successfully developed and results show that the square-shaped attachment may increase implant stiffness in extension and lateral bending. Addition of a sliding crosslink was found to increase implant stiffness in lateral bending and axial rotation. Additional mechanical tests should be performed, however, to investigate whether differences are significant. The FE model was developed but not validated yet. A first design of the implantable 'locking crosslink' based on a patient CT scan was completed and its application tested on an artificial vertebra generated from the same CT scan.