Personalized FE model of scoliosis brace treatment

Background Adolescent idiopathic scoliosis (AIS) is a complex 3D spinal deformity with a poorly understood pathogenesis. The causes of the initial deformity remain unknown, as does the question of why the curvature progresses in some patients and not in others. Detailed knowledge of the forces acting on the growth plates of the spine could contribute to a better understanding of the pathomechanisms and thus improve prevention and treatment strategies. Numerical models can complement the experimental data obtained in patients to gain a deeper understanding of this pathology. However, the accuracy of such simulations is highly dependent on the implementation of appropriate patient-specific load-related activities, such as exercise or brace treatment.

For AIS patients with mild scoliosis, treatment with a brace is common to limit or stop the progression of the disease as the patient grows. Nowadays, braces are custom-made for each patient using 3D printing techniques. The process is still largely empirical and relies heavily on the technician designing the brace based on the patient's x-rays. Numerical models could help to understand how the load is transferred from the ribs to the vertebral endplates, providing mechanical insights that can be used to optimize the procedure.

Aim The aim of this project is, therefore, to develop a patient-specific finite element (FE) model of the patient with a 3D-printed corset in order to evaluate the loads acting on the spine when wearing a brace.

Materials and Methods Computer simulations will be used to reproduce clinical data from AIS patients wearing a brace manufactured by Ortho Team Bern using 3D printing (https://www.ortho-team.ch/). The data used will be collected retrospectively; the design of the brace will be provided by Ortho Team, while the biplanar radiographic images will come from the treating physician. Initially, the pressure exerted by the brace on the body will be determined from the available literature, but in a second phase this information will be obtained by direct pressure measurements on patients wearing the patient-specific brace. The numerical model will consist of a simplified representation of the spine, ribs, and sternum embedded in a volume of soft tissue with a rough differentiation between the organs (e.g., lungs, muscles...). The model will be validated by comparing the positional correction of the spinal curvature determined in the model with the radiographic measurements taken while the patient is wearing the brace. (Figure 1)

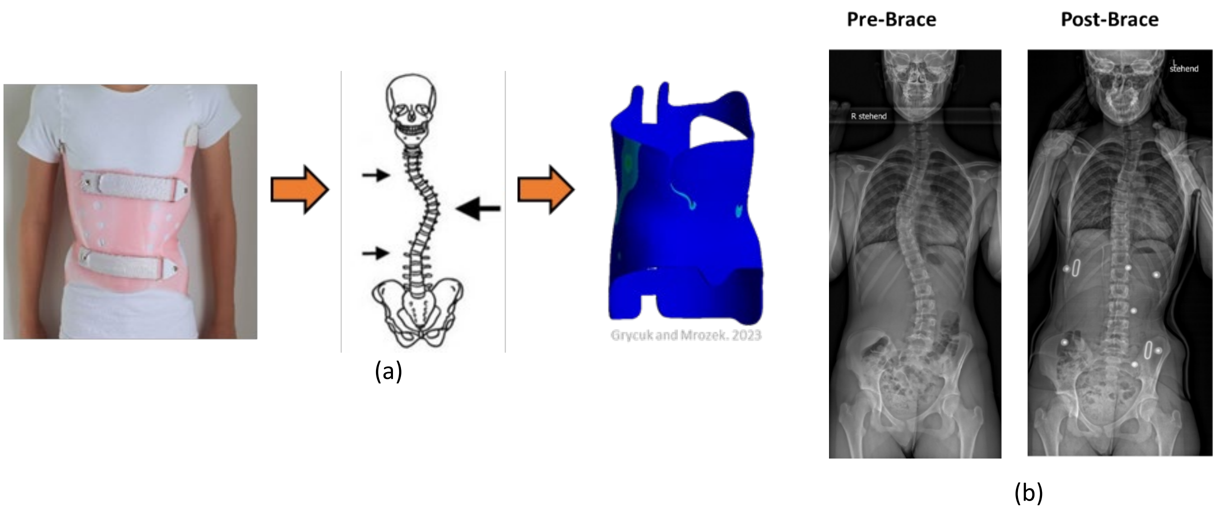

Figure 1: *Design of a brace for a patient with AIS produced by 3D printing (a). Radiographic images (EOS) of a patient without brace (left) and with brace (right) showing the change in the shape of the spine induced by wearing the brace (b).*

Nature of the Thesis:

- Data analysis and statistics: 25%
- Numerical modeling: 70%

Requirements:

- Knowledge of the finite element method
- Basics in Python

Supervisors:
Salvatore Conticello, ARTORG
Prof. Philippe Büchler, ARTORG

Location:
ARTORG Center in Bern

Contact:
Salvatore Conticello, salvatore.conticello@unibe.ch, Tel. + 41 31 684 14 32