Biomodeling

Michael Lovrity, *Biomedical Engineering, University of Rhode Island*
BME 281 First Presentation, October 7, 2013 <mlenard94@my.uri.edu>

***Abstract*— A computerized surgical planning tool, a desktop haptic device called a stereolithography (SLA) that are created from 3D computer model of the patient's spine and the pathology is generated from the patient's computerized tomography scan. The surgeon then performs virtual surgery to correct the pathology. With this new planning tool, this helps the surgeon with drilling and bone realignment that also help to predict the experience that will be encountered in the operating room. After the surgeon completes the mock surgery, computerized analysis is applied to adjust the surgical plan, and the rapid-prototyped spines models help communicate surgical planning information to the patient. Rapid prototyped drill guides are also used to improve accuracy of screw insertion.**

I. Introduction

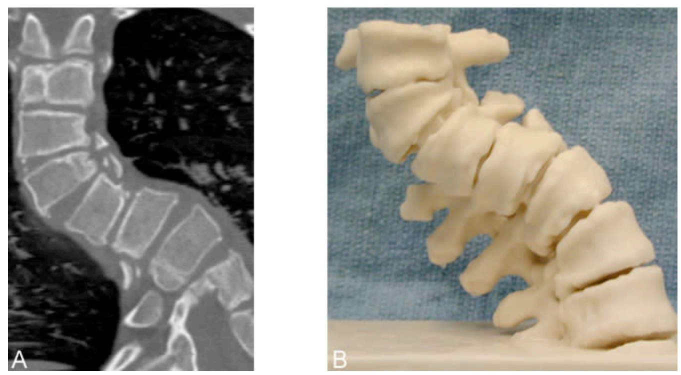
THE medical problem that many neurosurgeons face is the limited access to the information such as the treatment of complex severe spinal deformities, for example, scoliosis with a Cobb angle greater than 90°, critical spinal kyphosis, or vertebral and rib deformity with impaired lung capacity. Preoperative image studies including plain film radiography, computed tomography, and magnetic resonance imaging provide only two-dimensional (2D) images and limited information about these severe deformities. Also, these studies cannot directly offer visual or physical feedback for surgeons and patients. So, a new method called rapid prototyping biomodels of spinal discs. The biomodels were used preoperatively for surgical planning and customizing implants, and intra-operatively for anatomical reference. Currently, surgeons reported that the use of biomodels reduced operating time by an average of 8 percent in tumor patients and 22 percent in deformity procedures. This study supports that biomodelling is a useful, and important tool in the imaging techniques used for complex spinal surgery.

II. Methods

D'Urso first described the process of stereolithographic (SLA) biomodelling and its application to spinal surgery in 1999. Biomodelling accurately reproduces the morphology of a biologic structure from CT scans by using image processing software and a rapid prototyping device to produce a physical copy with the material acrylate. The procedures are that a Helical CT scans the spine to produce a series of axial images. The scans were then transferred to an image processing system that produced a model suitable for manufacture by SLA. SLA involves a liquid-bed laser curing system, where a laser traces contours and polymerizes a photosensitive liquid plastic monomer. The SLA biomodels has been found to have an accuracy of within 1 mm of the scanned anatomy. Artificial struts are built into the model, if needed, to position and hold separate structures in their anatomical positions. A typical model takes approximately 18 to 30 hours to build the SLA apparatus, depending on its geometry and volume. For cervical spine models or smaller spine segments can take between 12 and 16 hours to build the biomodel and the processing of CT data prior to building the model typically takes around 1 to 2 hours.

III. Results

The results of the spinal biomodelling based on five cases found that an accurate physical model of the spine is an effective tool to increase patient education and consent, preoperative planning and intra-operative stereotactic. A study using biomodels in 45 complex cranio-maxillofacial surgeries found that they had improved diagnosis, operative planning and reduced operative time. A later study of six patients in 2001 using biomodels concluded that they provided excellent understanding of the complex spinal pathology and helped surgical planning and performance.



IV. Discussion

The advantages of biomodels are that: 1) SLA biomodeling allows imaging data to be displayed in a physical form. 2) It allows accurate diagnosis and measurements to be made before surgery. 3) Give researchers a better understanding of the biomechanics such as the bracing of clubfoot. 4) Gives the patient a better understanding of where the problem is located and how it will be fixed. 5) Error rates are as low as between 1% and 6%. The disadvantages are of the technology were a minimum 24 hours' manufacturing time and the cost. The fragility is also a disadvantage of the initial wax mold, so small branches smaller than 1 mm could not be displayed in the final model. The costs for such custom-made models depend on size and are in the range of $1,800–$2,200. This includes 3D printing from based on the STL file, one tubular silicone model copy of the vascular area of interest, connection tubes, and a transparent Plexiglas box to connect the model lumen to a circulation circuit

References

[1] http://www.thebarrow.org/Research/Spinal_Biomechanics/205489
[2] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2200746/
[3] http://paulduroso.com/biomodelling.htm
[4] https://www.ncbi.nlm.nih.gov/m/pubmed/10382253/?i=6&from=/17846803/related
[5] http://www.ajnr.org/content/26/6/1425.full.pdf