BIOE 451/452: Bioengineering Design

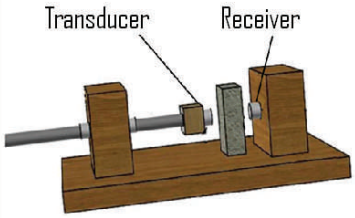
An opportunity for students to tackle and solve a design problem in bioengineering

April 2008

Ultrasonic Guide for the Placement of Pedicle Screws During Spinal Fusion Surgery

Placement of Pedicle Screws Used in Lumbar Fusion Surgery

Device for Testing the Propagation of Ultrasound Through Bone



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Bioengineering Design Challenge

In approximately 30% of lumbar fusion surgeries performed in the United States annually, the pedicle screws used to immobilize adjacent vertebrae are misaligned due to the difficult nature of correctly placing pilot holes through individual pedicles. This usually leads to fusion failure and almost always requires costly revision surgeries. Current methods such as computer aided surgery used to avoid this problem are far too costly and complex for orthopedic surgeons to use on a regular basis.

Appropriate Solution

After consulting with orthopedic surgeons and researchers in the field of biomechanics regarding this issue, several design objectives were defined by members of Team UPS for the development of their device, the PediSound. Most importantly, the design needed to be capable of determining the optimal drill angle through accurate bone thickness measurements prior to drilling. Additional design criteria also included "ease of use" in terms of the learning curve faced by surgeons to become proficient with the technology as well as the total operating time required for the device to perform its intended function. Finally, cost considerations were weighed against the need to create a modular device for easy sterilization and replacement of parts.

Current Status

The current proof-of-concept design of PediSound shows that ultrasound can be used effectively as a tool for measuring the thickness of a variety of materials that possess mechanical and acoustic properties similar to those of bone. These determinations have been successfully made with using basic straight through measurements based on the transmitted signal intensity between two transducers located on opposite sides of a test specimen. Testing has been conducted on bone analogs manufactured by the Sawbones corporation as well as other composite materials such as Styrofoam and PVC with a computerized algorithm for thickness detection . Future work involves devising a computer program and new holder to allow the transducer and receiver to be placed on the same side of the pedicle. UPS is targeting April 23, 2008 for the completion of a final working prototype of PediSound.

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