Design of a Dynamic Stabilization Spine Implant

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Arthritis, degenerative disc disease, spinal stenosis, and other ailments lead to the deterioration of the facet joints of the spine, causing pain and immobility in patients. Dynamic stabilization and arthroplasty of the facet joints have advantages over traditional fusion methods by eliminating pain while maintaining normal mobility and function. In the present work, a novel dynamic stabilization spine implant design was developed using computational analysis, and the final design was fabricated and mechanically tested. A model of a fused L4–L5 Functional Spinal Unit (FSU) was developed using Pro/Engineer (PTC Corporation, Needham, MA). The model was imported into commercial finite element analysis software Ansys (Ansys Inc., Canonsburg, PA), and meshed with the material properties of bone, intervertebral disc, and titanium alloy. Physiological loads (600N axial load, 10 N-m moment) were applied to the model construct following the protocol developed by others. The model was subjected to flexion/extension, axial rotation, and lateral bending, and was validated with the results reported by Kim et al. The validated FSU was used as a base to design and evaluate novel spine implant designs, using finite element anlysis. A comparison of the flexion-extension curve of six designs and an intact spine was carried out. Range of motion of the new designs showed up to 4 degrees in flexion and extension, compared to less than one degree flexion/extension in a fused spine. The design that reproduced normal range of motion best was optimized, fabricated and prepared for mechanical testing. The finalized dynamic stabilization design with spring insert was implanted into a L4-L5 FSU sawbone (Pacific Research Laboratories, Vashon, WA) using Stryker Xia pedicle screws. The construct was potted using PMMA, and was subjected to flexion/extension, axial rotation, and lateral bending loads using MTS mechanical testing machine. The stiffness of the design was assessed and compared with computational analysis results.

Cardiac Arrest Alert System

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According to the American Heart Association, approximately 166,200 out-of-hospital cardiac arrests occur each year. It is estimated that a victim's chances of survival are reduced by 7-10 percent for every minute that passes without treatment. Obviously, time is very critical in such situations. In most cardiac arrest cases, there is little to no warning to the victim that their heart has stopped and thus no time to notify others that emergency care is immediately required. To help alert the victim and others that a cardiac arrest episode has occurred, an ambulatory alarm and notification system has been built for individuals at high risk of cardiac arrest. The cardiac arrest alert system uses a ring-style photoplethysmograph that is connected to an armband unit which performs signal processing and wireless transmission and possesses an audible alarm. A wristband interface provides visual and tactile warnings, a reset button and a threshold adjuster. If the user's heart rate goes outside the preset range or is not detected by the system, a visual and tactile warning notifies the user of the situation. If the device is not reset or the problem not rectified within several seconds, the device then goes into full activation mode and sounds a loud alarm to notify nearby individuals who may be able to provide emergency assistance to the user. In full activation mode, the device also wirelessly transmits a signal to a central unit that, when signaled, automatically calls 911 and plays a pre-recorded message that states the incident and specifies the location. An additional phone number can also be stored so that another notification call is automatically performed. The central unit has a speaker so that the notification message is locally audible as well. In emergency situations, the cardiac arrest alert system will provide a life-saving service by rapidly alerting the user as well as nearby individuals and emergency respondents who can provide immediate assistance.