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Finite element analysis of effectiveness of fracture fixation plate made of shape memory alloy

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Abstract: Bone is the main constituent of the skeletal system and its rigidity and strength distinguish it from the connective tissues. Fatigue and impact loads are the most common reasons for bone fracture. Fractured bones need to be fixed surgically for its healing and proper functioning as early as possible. The basic goal to use fracture fixation techniques is to avoid the misalignment of fractured bone parts and to enable fast healing. Bone-plate screws are widely practiced fracture fixation technique. Several advancements in design of bone-plate screw had been done. Although, the screws are require to drill into the bone to assemble the plate with bone. Once screws are removed, It has been seen that the holes usually remain in the bones, which may cause risks of secondary bone fractures. Large difference in stiffness of plate material and bone may cause the osteoporosis and stress shielding. In consideration of such problems, shape memory alloys emerge as an effective material to be used for fracture fixation plate. So, the effectiveness of shape memory alloy as a fracture fixation plate material should be investigated.

The concept of bone fixation plates made of shape memory alloy is that it wrapped over the entire fracture area using the shape memory effect at human body temperature. The plate made of shape memory alloy has both materialistic as well as design advantages over the existing bone-screw plate made of stainless steel or titanium alloys. The stiffness of shape memory alloys basically nitinol (NiTi) is relatively close to bone and also possess the higher degree of biocompatibility as compared to stainless steel and titanium alloy along with it provide selective stress shielding. So, this study is based on finite element analysis and considering the different design parameters like length of plate, circumferential angle, number of ribs etc. based on the optimum mechanical environment around the fracture site to stimulate fracture healing rate.

Keywords: Fracture fixation plate, shape memory alloy, optimum mechanical environment, FE analysis.