POTENTIAL USE OF NiTi IMPLANT FOR INTRA-ARTICUAR FRACTURE OF PHALANX

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INTRODUCTION: Shape memory alloys (SMAs), are recently creating great interest in a number of scientific and commercial areas. In medical field, NiTi stent, staple and guidewire are three successful examples of application. [1-3]

Intra-articular fracture of phalanx is a common fracture. Without proper treatment to restore its anatomical shape, it always associates with complications in pain and limited range of movement. The present treatment is using an external fixator across the joint to hold the finger in right position. Although the external fixator is effective, it is bulky and uncomfortable. Moreover, the pin track infection is a potential concern.

Our implant design is aimed to provide an optimum distraction force yet to resist the deforming force and to keep the fragments in position with the compression of the surrounding soft-tissue like joint capsule and ligaments. By using the special shape change phenomena of the SMA, an internal implant design prototype was developed.

In this study, the axial distraction performance of the external fixator (Pennig Mini-external fixator, OrthoFix) and our SMA implant were assessed by a biomechanical testing method with cadaver proximal inter-phalangeal joint (**PIPJ**) model.

METHODS: In this study, NiTi wires (Figure 1) were used to provide a distraction force across the finger joint. The original length of the NiTi implant was 18mm and it was compressed to 13mm. Hence a distraction force can be produced when the NiTi implant change back to its original shape after being heated.

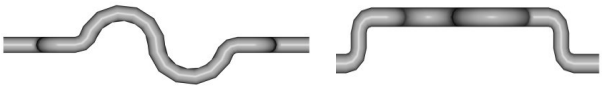

Fig. 1: The shape of the NiTi implant is S- shape in the top view (Left). The hooks on the ends are to provide a self-lock mechanism (Right).

6 PIPJs without deformities were used in the study. In this experiment, 858-MTS material testing system was used to apply a cyclic loading of 20N with 1N/s to 3 different PIPJ configurations. The respected displacement was recorded by the system.

RESULTS: The stronger the distraction force, the shorter the retardation in specimen. Thus, the device is said to be able to resist the axial compressive force when the retardation was small after the cyclic loading.

N=6	Normal	Ext. Fixator	NiTi wires
Ave. retardation (mm) after 5 cycles 20N loading	0.198 (0.086)	0.099 (0.057)	0.024 (0.028)

From the above table, the NiTi wires showed a shorter retardation than the external fixator did. And therefore, the NiTi wire can provide a larger distraction force for fracture reduction.

DISCUSSION & CONCLUSIONS: The NiTi wires seem to have a superior result over the external fixator in providing distraction force. NiTi implants not only can provide large distraction force, they also have the benefit of small size and potential use as internal implant. The NiTi implants thus have potential to be used as finger fracture fixation device. However much more work should be done such as investigation of NiTi implants against bending and torsion. Animal or clinical test should also be carried out.

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