The Role of Soft Tissues in Rigidity of Fracture Fixation of Upper Extremity; application for battlefield use

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Objectives
A typical war injury is an open fracture with soft tissue deficits called a "slot defect" here. This study was designed to evaluate the rigidity/stiffness of different fracture fixation techniques when a slot defect has occurred. Soft tissue compression (STC) in functional braces has been shown to provide rigidity and stability of most closed fractures, selected open fractures and can supplement some other forms of fracture fixation. The rigidity of 3 types of fracture fixation with intact soft tissue (ST), then progressive ST defects & bone loss were tested in the upper extremity.

Methods cont.
Lims were randomly assigned to be stabilized be either plate and screw (PS), intramedullary nail (IMN) or external fixation (EF). Testing with and without STC in a brace was performed after each condition, (Figure 1A). ANOVA multi-variant analysis corrected for multiple comparisons was used to compare the axial rigidity between the different conditions tested. In an additional 36 forearms, bending rigidity was measured using a modular fracture brace with external fixation (Figure 1B).

Findings
There was no significant difference in axial rigidity for humerus fractures treated by any of the methods related to the degree of soft tissue damage. EF provided the least rigid fixation for humeri with a 3 cm bone defect and were the most improved with STC. Forearms fixed with PS were significantly more rigid than any other method. EF was the least rigid and was improved the most with STC. Progressive increase in soft tissue defects created progressive loss in rigidity in forearms, but the most dramatic loss occurred with the bone defect and ST defect. (Graph 1 and 2) The increase in resistance to bending was most significantly improved with STC. (Graph 3)

Conclusions
Invasive types of surgical intervention provide the best rigidity to fractures, regardless of the presence of or size of a soft tissue defect. PS, IR and conventional braces are not practical for field application. EF, however, can be applied quickly and easily with a minimal of facilities in the battlefield end can be applied in such a way that no foreign bodies end up in the contaminated wound. For injuries to the forearm, supplemental support from STC with a splint or brace-like system could be effective.

Implications
The use of external fixators combined with fracture bracing can be applied quickly and facilitate transportation to a hospital for evaluation and treatment. Our future research involves improving the modular functional fracture brace system which is designed to be assembled to fit the external fixators construct for acute management of forearm and lower leg injuries with and without soft tissue damage.

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