Biomechanical Stiffness and Strength of New Versus Reused Stainless Steel Uniplanar Tibial External Fixator Constructs in a Low-Resource Setting

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ABSTRACT

INTRODUCTION. External fixation is used in the initial or definitive management of open fractures. Branded fixators are costly and often unavailable in low-resource countries. Low-cost locally available stainless steel fixators are relatively easy to procure. When these low-cost fixators are depleted in hospitals and purchase cost is prohibitive for patients, the reuse of non-implanted components (the rods and clamps, referred to as outriggers) is a frequent alternative. New Schanz pins should be implanted into bone to reduce the risk of infection. The reuse of outriggers translates to significant savings both for hospitals and patients. Knowing the stiffness and strength of reused versus new fixators will help guide their policies regarding reuse.

OBJECTIVES. The general objective of this study was to assess the biomechanical stiffness and strength of both new and previously used external fixator constructs available in our hospital. Specifically, this study compared the axial stiffness, bending stiffness, torsional stiffness, and ultimate strength of new versus previously used low-cost uniplanar tibial external fixator constructs. In addition, this study compared the axial stiffness and ultimate strength of an all-new low-cost uniplanar tibial external fixator constructs using five Schanz pins versus six Schanz pins.

METHODOLOGY. Forty-five plastic tibia were osteotomized at midshaft to create a fracture gap, simulating a comminuted diaphyseal fracture. Tibias were randomly divided into three groups of fifteen specimens. Each tibia was stabilized using five new Schanz pins in a uniplanar configuration held by one of three constructs: 1) with all-new components, 2) once-used and re-sterilized outriggers, or 3) twice-used and re-sterilized outriggers. Specimens were then biomechanically tested to determine fixation stiffness in axial compression, bending, and torsion. Static loading until failure was also performed to determine ultimate construct strength.

A fourth group of five specimens (osteotomized tibias) were stabilized using all-new components with six Schanz pins (three pins in each fracture segment). These specimens were tested to determine axial stiffness and ultimate strength. Results were then compared to the first group (5-pin all-new components).

RESULTS. There were no significant differences among the first three groups in terms of axial stiffness, axial strength, and bending stiffness. In the torsion test, the reused fixators were even stiffer than the all-new group.

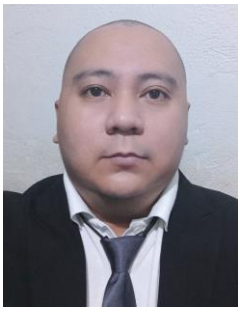
The all-new fixators using six Schanz pins were significantly stiffer and stronger versus the all-new fixators using five Schanz pins.

CONCLUSION. Reused, locally available stainless steel uniplanar tibial external fixators were mechanically comparable to new fixators in terms of axial stiffness, bending stiffness, and ultimate strength. Reused fixators were superior in terms of torsional stiffness versus new fixators. The reuse of non-implantable fixator components is a viable option without compromising construct mechanical strength even if the components have undergone two cycles of clinical use and reprocessing.

The study also concludes that in using new external fixators, increasing the number of pins from five Schanz pins to six Schanz pins increased the construct's axial stiffness two times and increased the construct's axial strength four times.

BIOGRAPHY

Cris S. Dedumo is a chemist and an orthopedic surgeon. He finished his orthopedic residency training from Northern Mindanao Medical Center where his paper was published in The Philippine Journal of Orthopaedics last November 2023. He is interested in doing research.



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