

# Mechanical comparison of two types of fixation for Ludloff Oblique First Metatarsal Osteotomy under cyclic loading

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**Introduction:** The Ludloff oblique metatarsal osteotomy is effective in obtaining significant correction in case of severe hallux valgus deformities [1]. Problems related to it are inherent instability, delayed union, dorsal malunion and fixation failure with a loss of correction dictating revision. This study aims to evaluate the mechanical benefits of supplementary fixation by using a mini locking plate [2].

**Materials and method:** Twenty identical 4<sup>th</sup> generation composite Sawbone® models were used. A Ludloff osteotomy was performed on each one. Half of them were fixed adopting the classic technique (Fig.1a), i.e. with two screws (Class-I) while in the remaining ones (Class-II) the two-screw fixation was reinforced with a mini locking plate applied medially (Fig.1b). The base of each specimen was clamped with the metatarsal inclined 15° with respect to the horizontal plane (corresponding to the anatomic standing position), with the plantar aspect of the metatarsal facing upwards. The plantar aspect of the metatarsal head was loaded by a loading ram in a cantilever bending mode with a moment arm of 55 mm using a servohydraulic test frame (MTS Mini Bionix 858). Three specimens of each group were loaded to failure under quasi-static conditions. Cyclic testing was performed under load-control mode at a maximum load equivalent to 70% of the static failure load of the weakest construct and frequency equal to 3 Hz. The test was terminated either in case of bone fracture or screw pullout or development of osteotomy gap greater than 2 mm or when the cycle number reached an upper limit (300,000) [1]. During the cyclic loading tests a 3D Digital Image Correlation system (DIC, LIMESS, Krefeld, Germany) was used to measure the gap across the osteotomy site (Fig.3) and the correction-angle loss. A Student t-test was used to determine statistical significance ( $\alpha=0.05$ ).

**Results:** Nine out of fourteen specimens reached 300,000 cycles. It was concluded that only the first 5,000 loading cycles are of critical importance concerning the clinically relevant mechanical quantities. In addition Class-II specimens were found to develop significantly lower gap across their osteotomy in comparison to Class-I specimens (Fig.3).

## References

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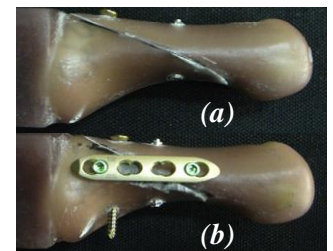


Fig.1 Typical I- (a) and II-class (b) specimens



Fig.2 Experimental set-up

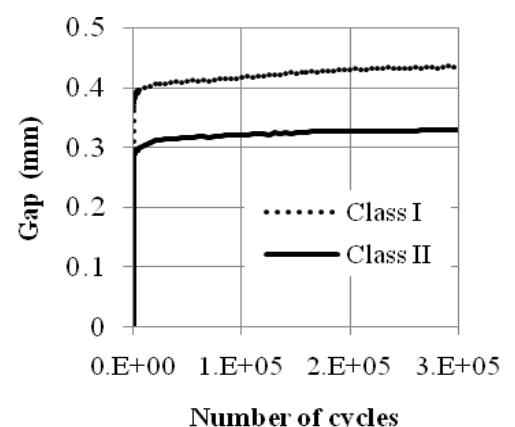


Fig.3 The gap versus the number of cycles for two typical specimens