Risk Factors for First Tarsometatarsal Joint Slippage After Third-Generation Minimally Invasive Bunionectomy: A Weight-Bearing CT Scan Assessment.

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INTRODUCTION:

Third-generation minimally invasive (MIS) bunionectomy requires a lateral shift of the metatarsal head, pushing the shaft into adduction and levering off the 1^{ST}-tarsometatarsal (TMT) joint. A previous study on plain radiographs reported postoperative 1^{ST}-TMT joint slippage in the transverse plane, with a medial subluxation of the 1^{ST} metatarsal base. However, risk factors and clinical implications have yet to be determined. This study sought to assess the prevalence of postoperative 1^{ST}-TMT joint slippage in the transverse plane and to identify associated risk factors using weight-bearing CT (WBCT) scans. In addition, the effect of 1^{ST}-TMT slippage on postoperative midshaft foot width was investigated. We hypothesized that postoperative 1^{ST}-TMT slippage in the transverse plane would be associated with preoperative 1^{ST}-TMT instability and increased postoperative midshaft foot width.

METHODS:

Sixty-three consecutive patients who underwent MIS bunionectomy with available pre- and postoperative WBCT-scans were included. Radiographic measurements included hallux valgus angle(HVA), intermetatarsal angle(IMA), and midshaft foot width, measured from the 1^{st} metatarsal shaft to the 5^{th} metatarsal head on AP-foot radiographs. Tri-planar rotation angle(TAP), and 1^{ST}-TMT plantar-gap and medial-middle(MM) intercuneiform distances(mm) were obtained from WBCTs. Two raters measured pre- and postoperative 1^{ST}-TMT distances between the most lateral aspect of the medial cuneiform and 1^{ST}-metatarsal base at the dorsal, central, and plantar thirds on axial cuts. The average corresponds to the overall 1^{ST}-TMT lateral distance, a measure of 1^{ST}-TMT slippage. Rater agreement was assessed. Paired t-tests were used to compare pre- and postoperative values. Logistic regression models were used to investigate the association of postoperative 1^{ST}-TMT lateral distance with potential risk factors (preoperative 1^{ST}-TMT lateral distance, 1^{ST}-TMT plantar-gap distance, IMA, TAP, and MM intercuneiform distance) and postoperative midshaft foot width.

RESULTS:

The interobserver reliability of the 1^{ST}-TMT lateral distance was excellent (r=0.97). Mean (SD) 1^{ST}-TMT lateral distance increased from 0.26 mm(0.4) to 1.33 mm(0.9) after surgery(P<0.05). Postoperative 1^{ST}-TMT lateral distance was > 2 mm in 15 patients(24%), and > 1 mm in 33(52%). Mean(SD) dorsal 1^{ST}-TMT lateral distance (2.7mm[1.3]) was significantly higher than central (0.85mm[1.1]) and plantar (0.55mm[0.99]) 1^{ST}-TMT lateral distances. Mean(SD) midshaft foot width increased from 80.04mm(6.7) to 84.25mm(6.1) postoperatively (P<0.05). Regression analysis showed that pre- and postoperative 1^{ST}-TMT lateral distances were correlated (Coef=0.64,P=0.02), and identified a 1 mm increase in postoperative 1^{ST}-TMT lateral distance with each 0.63 mm increase in preoperative 1^{ST}-TMT plantar-gap distance (Coef=0.63,P=0.008). A significant positive correlation was also observed between postoperative 1^{ST}-TMT lateral distance and postoperative midshaft foot width (Coef=1.43,P<0.05).

DISCUSSION AND CONCLUSION:

Our study suggests a possible association between postoperative 1^{ST}-TMT joint slippage and preoperative 1^{ST}-TMT multiaxial instability following MIS bunionectomy. This raises an important question as to whether alternative techniques, such as modified Lapidus, should be preferred over MIS bunionectomy in patients with 1^{ST}-TMT instability. Notably, medial slippage was significantly higher at the dorsal aspect of the 1^{ST}-TMT joint, suggesting a component of rotational instability. It appears that 1^{ST}-TMT slippage is associated with a wider midshaft foot width postoperatively, and patients should be warned about it. Future studies assessing mid-to-long-term effects of 1-TMT slippage, like recurrence or degenerative changes, are warranted.

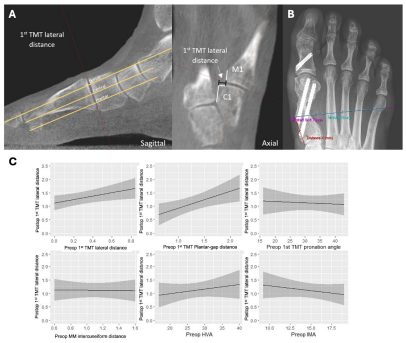

Fig. 1A: Measurement method for the 1ST-TMT lateral distance on WBCT scans.
To obtain the reoriented axial plane, the sagittal plane crosshair was rotated to parallel the 1ST-TMT joint (left), whereas the coronal plane crosshair was turned orthogonal. The 1ST-TMT joint was divided into three-thirds from dorsal to plantar (left). Final measurements were performed in the reoriented axial image between the most lateral aspect of the medial cuneiform and 1ST metatarsal base at the midpoint of the dorsal, central, and plantar thirds of the 1ST-TMT joint (right). The postoperative 1ST-TMT lateral distance (a measure of 1ST-TMT slippage) was obtained from the average of the dorsal, central, and plantar distances.
Fig.1B: Measurement of midshaft foot width.
The red line established the most medial landmark of the 1ST-metatarsal shaft by extending a line from the 1ST-metatarsal base. The blue line corresponds to the midshaft foot width, which extends from the established most medial landmark to the outermost extent of the 5th metatarsal head.
Fig. 1C: Partial logistic regression plots with postoperative 1st-TMT joint lateral distance (a measure of 1ST-TMT slippage) as the outcome.
Increased postoperative 1ST-TMT lateral distance was significantly associated with preoperative 1ST-TMT lateral distance (Coef = 0.64, *P* = 0.02). The regression model identified a 1 mm increase