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Range of motion in the 1st tarsometatarsal joint after temporary bridge plate fixation: Computed tomography (CT)-based analysis after 5 years



Magnus Poulsen MD*, Are H. Stødle MD PhD, Stephan M. Röhrl MD PhD
Division of Orthopaedic Surgery, Oslo University Hospital, Norway.
* Contact info: japoul@ous-hf.no / +47 977 29 404

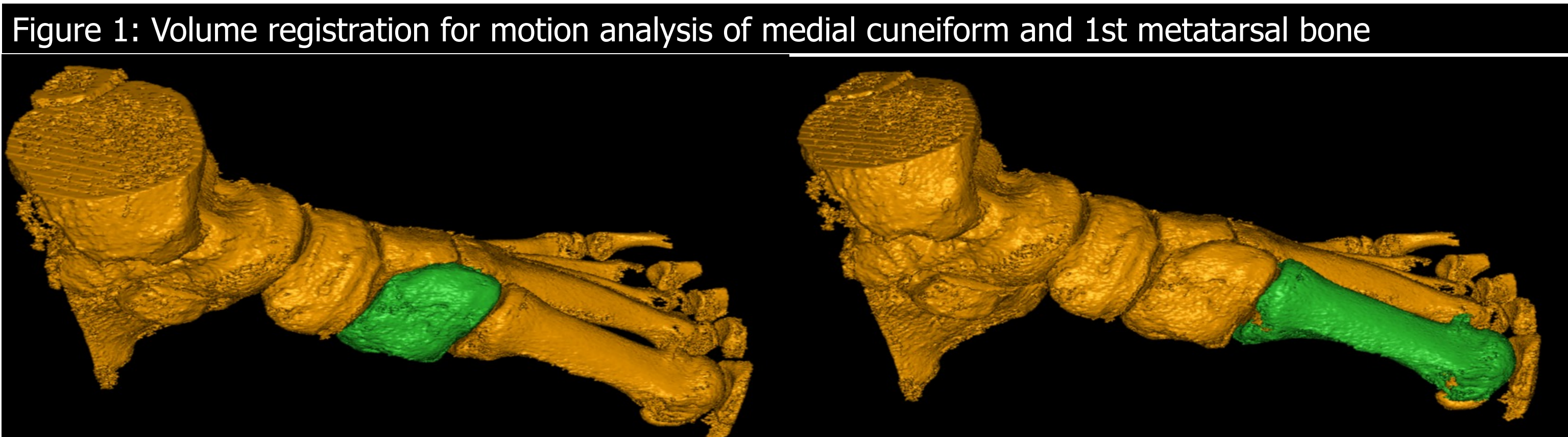
Objective

The aim of this study is to explore a new CT-based micromotion analysis (CTMA) software combined with Cone beam–CT (CBCT) to examine the full range of motion in the 1st tarsometatarsal (TMT) joint after treatment with a temporary bridge plate fixation.

Introduction

Accurate midfoot range of motion is difficult to quantify by radiographic imaging alone. Radiostereometric analysis is considered the gold standard for *in vivo* motion analysis. However, the method requires specialized entities and is rarely used in clinical settings. Low-dose CT provides direct 3-dimensional data and can serve as a suitable substitute for RSA. There are indications that CT could be an alternative to RSA without significant loss of accuracy (1).

Here we examine and compare 1st TMT-joint range of motion in patients previously treated for a unilateral, unstable Lisfranc injury with a temporary bridge plate fixation.

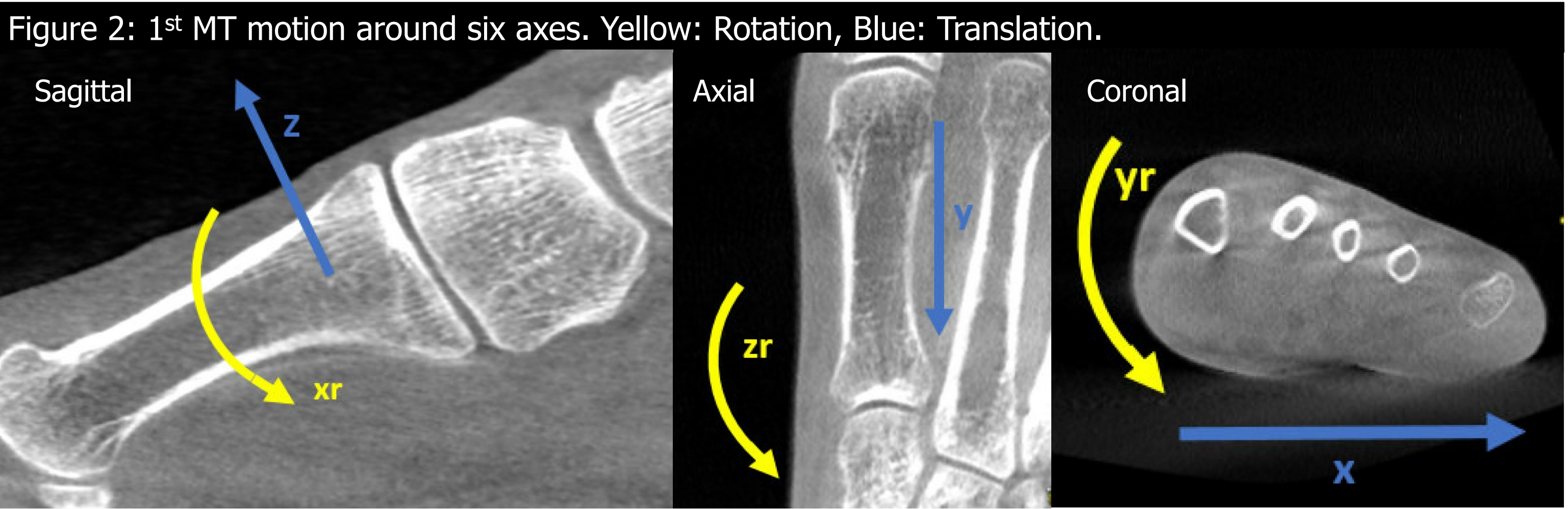


Material and Method

- We examined **16 feet** (8 patients) that had previously been treated with a **unilateral, temporary bridge plate fixation** over the 1st TMT joint.
- Minimum inclusion time was five years post-operative.
- We obtained **CBCT examinations** during non- and full weight-bearing sequences of both feet.
- Lisfranc joint motion was analyzed using a **volume registration technique** (CTMA - Sectra, Sweden) with the **medial cuneiform as fixed object** and the **1st metatarsal as moving object** (Figure 1).
- The motion of the 1st metatarsal (MT) bone relative to the medial cuneiform (MC) is expressed in six degrees of freedom representing rotation and translation along x, y, and z axis in a CT-based coordinate system (Figure 2).
- Using the nonsurgical side as reference, we **examined and compared 1st TMT motion** in the surgical foot.
- CTMA precision was determined by 32 double examinations comparing the proximal and distal part of the 1st metatarsal bone separately. Precision of measurement was defined as “the degree of closeness between a measured value and the true value being zero motion”.
- Clinical outcome parameters were documented with the **American Orthopedic Foot- and Ankle Society (AOFAS)** midfoot score.

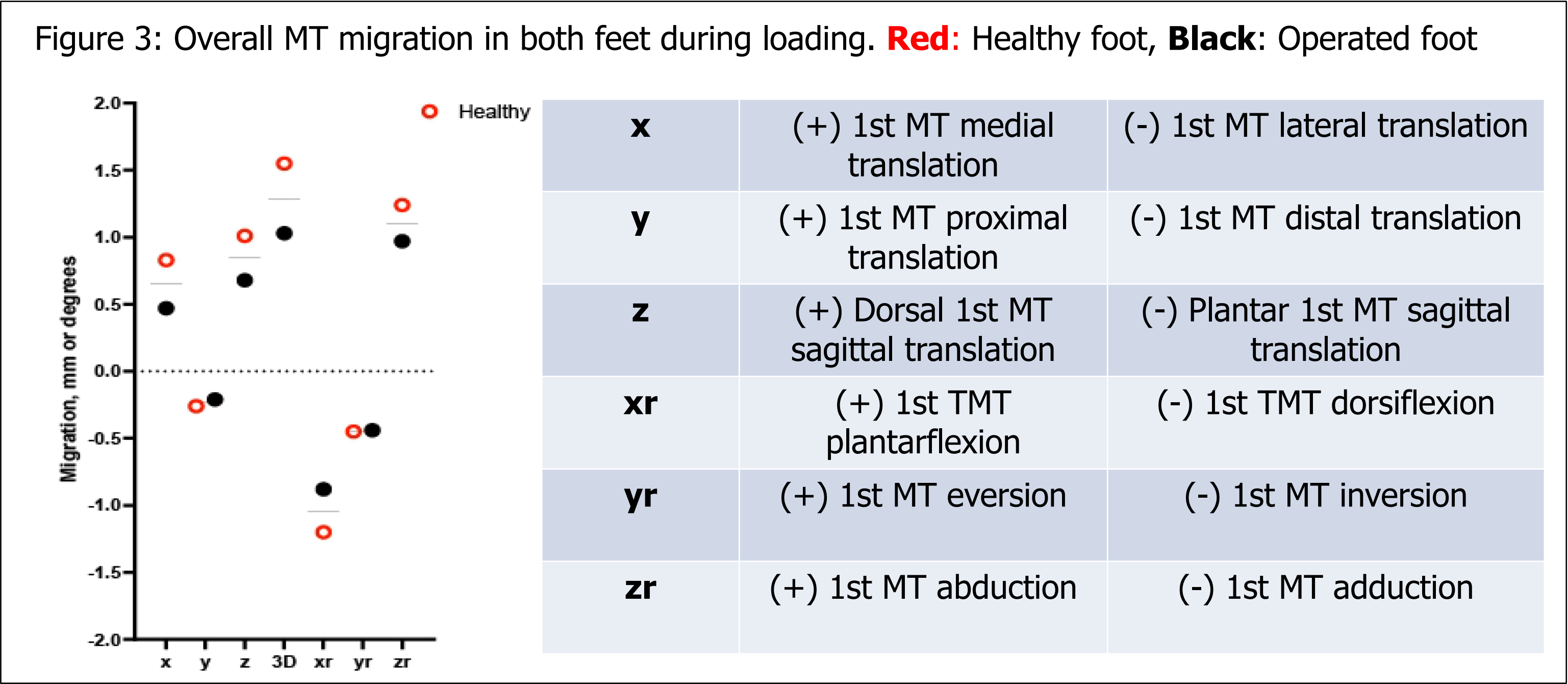
Conclusion

The use of CTMA together with CBCT is applicable to micromotion analysis of the Lisfranc joint with comparable precision to other published studies (1). The 1st MT moves in 3 directions relative to the MC during weight bearing. This motion is preserved but reduced in patients treated with a temporary bridge plate fixation.



Results

- Median **follow-up time was 5.8 years** post operative (range 5.1 – 6.9 years)
- CTMA software precision was in the range of 0.10 – 0.12 mm for translation and 0.20 – 0.29° for rotation.
- Under physical load, **primary movement was observed in the zr axis** (1st MT abduction, median 1.2°), **the xr axis** (1st TMT dorsiflexion, median 1.1°), **and z-axis** (dorsal 1st MT translation, median 0.9mm) (Figure 3).
- Although preserved, **movement is reduced in all six axes in the previously operated Lisfranc joint** compared to the healthy foot.
- Median **AOFAS score was 99** (range 63 - 100).



Discussion

Combining low-dose CBCT images with volume registration software is a noninvasive method of examining the kinematic properties of the Lisfranc joint. Temporary bridge plate fixation is in theory a motion-preserving osteosynthesis. Regaining natural TMT motion after treatment with this surgical method is observable in our patient group. However, the TMT motion detected in our study is based on static images alone, as opposed to dynamic radiography, and does not represent the total range of motion in the examined joint. Clinical outcome parameters suggest an excellent long-term outcome with this surgical method.