Nitinol Shape Memory Staple Fixation of Lisfranc Fractures is Safe and Efficacious

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Introduction/Purpose: Surgical treatment of Lisfranc fractures has evolved from arthrodesis or transarticular screw fixation to joint preserving modalities (suture buttons and/or dorsal spanning plates), the latter commonly requiring removal due to metalwork irritation and to restore motion at the 1st-MTPJ. Shape memory staples formed from Nitinol exploit its biomechanical properties of; low Young’s modulus, super elasticity and high ductility. To produce a robust implant that generates greater compressive forces at its distal end compared to traditional 316L stainless steel compression staples. Permitting the construction of a rigid fixation for Lisfranc fractures that is achieved with transarticular screws or plate fixation, but is mobile and elastic as with suture buttons. This study aims to assess the surgical outcomes of staple fixation in acute Lisfranc fractures.

Methods: A prospective study to assess for union and necessity for revision surgery was completed for consecutive Lisfranc fractures treated with Nitinol shape memory staple fixation from June 2020 at a single U.K. Level 1 Major-Trauma-Centre. All operations were performed or supervised by a single fellowship trained Major Trauma Foot & Ankle Surgeon through a EHL bed approach to access the base of the 2nd MT and cuneiforms. Relevant joints were debrided and reduced, held with K-wires and reduction clamps to allow for the placement of the staples. A triangular configuration for the placement of three staples (2nd MT to Middle Cuneiform, 2nd MT to Medial Cuneiform, Middle to Medial Cuneiform). Reduction of the Lisfranc complex was confirmed on intra-operative fluoroscopy. Patients were non-weight bearing for 4 weeks with appropriate VTE prophylaxis. Staples were placed so as to not penetrate the plantar cortex and inter-cuneiform instability was assessed and confirmed intra-operatively.

Results: Results from 19 consecutive patients were analysed, consisting of 9 men 10 women, with a mean age of 44 years (19-76). Seven patients sustained high energy trauma. Mean time to theatre was 18 days (5-28) from date of injury. Mean total operative time was 70 minutes, (27-154) with an mean tourniquet time of 63 minutes. An mean length of follow-up was 13.5-months (range 6-20 months), with a 100% union rate on weight-bearing radiographs and no incidences of post-operative complications requiring further medical or surgical intervention. No patients reported symptomatic implant irritation which required consideration of metalwork removal. The average FADI score was 73/104 (70%) at longest follow-up.

Conclusion: Nitinol shape memory staple fixation of Lisfranc fractures is safe and efficacious, removing the necessity for metalwork removal as is commonly seen with dorsal bridging plates whilst maintaining the structural rigidity of plate/trans-articular screw fixation at the same time as allowing for physiological motion at the 1st-MTPJ. Patient reported outcome measures of this technique demonstrate equitable outcomes to more conventionally used techniques. This is the largest series of shape memory alloy staple fixation of acute Lisfranc injuries the authors are aware of and demonstrates that this technique should be considered a part of a surgeons' armamentarium when treated Lisfranc injuries.
