Novel Techniques for Superior Fixation of Patella (34C) Fractures

Jonathan Lenihan, MBBS*; Sonia Ramos Pascual; Pavlos Silvestros; Philip Beak, BA, MBBS; Anthony William Miles, PhD; Alex Trompeter*
University of Bath, Department of Mechanical Engineering, Bath, United Kingdom

Purpose: Patella fractures account for 1% of all fractures. Traditional tension-band wiring (TBW) remains the standard treatment for most patella fractures. Complications from this surgery include prominence/failure of metalwork, infection, and wound dehiscence. It can be technically challenging to site the longitudinal Kirschner wires (K-wires) without further damage to the quadriceps and patellar tendons. Failure to respect the soft tissues coupled by malposition of the metalwork can lead to complications. We have designed 3 novel techniques for fixation of 34C fractures using the same materials as those for TBW. Principally we have moved the longitudinal K-wires to a crossed position to facilitate ease of insertion and minimize soft-tissue trauma. We also considered the implications of moving the TBW to the sides as opposed to the dorsal surface of the patella.

Methods: An initial proof of concept was undertaken on human cadaveric knees to ensure the configurations could be constructed in a manner representing safe and reproducible surgery. A biomechanical study was then undertaken on porcine patellae. The method was based on published techniques and a specially designed rig was constructed. After dissection 34C fractures were created. One author performed reduction and fixation. Load was applied from an Instron 5965 5Kn Universal Testing Machine. Displacement was measured by a Caldaro S8FLP-10A-10K linear variable displacement transducer (LVDT) fixed on either side of the fracture. Specimens were tested cyclically from 90°-45° at a rate of 6.7 seconds for 100 cycles. The load and displacements (incremental and overall) were measured using Bluehill software and the LVDT recordings. Data were blindly analyzed for all tests that reached 100 cycles. The Initial cycle was defined as the 5th cycle to allow for any slack within the system to be taken up. Incremental displacements/cycle were derived from the data sets at 3 set points: 5, 50, and 100 cycles and were defined as the Initial, Mid, and Final cycles.

Results: 17 of 22 specimens achieved 100 cycles. Cross K-wire with side TBW performed best with average fracture displacement (AFD) of 0.43 mm under average load of 84.1 N. The cross K-wire with standard TBW achieved an AFD of 0.61 mm under average load of 69.2 N. Standard TBW construct achieved AFD of 1.72 mm under average load of 79.6 N. Longitudinal K-wires with side TBW performed worst with AFD of 1.93 mm under average load of 75.4 N. The final incremental displacement/cycle for both cross K-wire configurations was 0.27 mm compared to 0.41 and 0.60 mm for standard TBW and longitudinal wires with side TBW respectively. This is evidence of the cross K-wire configuration conferring greater stiffness to the fracture gap under loading.

Conclusion: This study shows biomechanical superiority for 2 novel constructs: cross K-wires with standard figure-of-8 or side TBW compared to gold-standard TBW. They require no increase in terms of resources and incur less soft-tissue trauma, which may reduce complications.