TIBIAL TUBEROSITY TRANSPOSITION-ADVANCEMENT FOR LATERALISATION OF THE TIBIAL TUBEROSITY: AN EX VIVO STUDY

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Introduction

Successful correction of medial patellar luxation (MPL) in dogs relies on normalisation of the vector of the quadriceps mechanism (the Q-angle), reducing the medial force on the patella. This can be accomplished with lateralisation of the tibial tuberosity (TT), which is generally secured with a pin and tension band (PTB). Complications associated with this technique include reluxation and implant-related complications. The incidence of complications related to PTB wiring of the TT has been described at 3.8%. Reluxation can be seen in up to 8% of cases in which a TT transposition has been performed. The amount of lateralisation is limited as the osteotomy must be reattached to an adequate bone bed on the craniolateral proximal tibia.

Tibial tuberosity transposition and advancement (TTTA) has been described by Yeadon (2011) for treating concomitant MPL and cranial cruciate ligament rupture. This slight modification to the TTA procedure allows lateralisation and advancement of the TT, and proximodistal realignment of the patella. Implant complications were not seen in a case series of 32 dogs, although the reluxation rate exceeded 10%.

The aims of this study were to evaluate the degree of lateralisation achievable with TTTA relative to the PTB technique, and to compare the mechanical performance. We hypothesised that the TTTA would allow a similar degree of lateralisation of the TT with increased mechanical strength.

Materials and Methods

12 paired cadaveric tibiae were dissected free of all soft tissues excluding the patella tendon and patella. Tantalum beads were implanted in the most caudal aspects of the medial and lateral tibial condyles, the cranial intercondylar area, and the TT at the insertion of the patellar tendon.

CT was performed before and after surgery. The 3 tantalum beads in the articular surface were used to establish a repeatable plane of measurement, and the cranial position of the TT was measured relative to a reference line drawn between the two caudal markers. The mediolateral position was measured relative to a line perpendicular to the reference line at the medial marker.

One bone from each pair was randomly assigned to the TTA group and the other bone to the PTB group.

PTB procedure: a standard TT transposition was performed, with osteotomy of the TT leaving the distal periosteum intact, and the fragment was rotated laterally. This was secured with two 1.6mm Kirschner wires and 1.0mm orthopaedic wire in a figure-of-8 tension band.

TTTA procedure: A TTTA was performed with a size 6 plate and fork and a 6mm cage. The degree of lateralisation was 50% of the measured cage depth, achieved by placing 1 or 2 spacers between the cranial cage ear and the medial TT.

The measurements of TT position were repeated with CT, and percentage of lateralisation and craniocaudal deviation were calculated.

Destructive tensile testing was performed at a displacement rate of 20mm/min with a servohydraulic testing machine. The tibia was potted, whilst proximally the patella was slotted into a custom-made fixture and distracted with a PTA of 90°. Peak load, energy to failure and stiffness were derived from the force-displacement output. The mode of failure was noted. Data were represented as mean +/- standard error, and compared using paired Student’s T-test.

Results

The mean degree of lateralisation of the two groups was significantly different (PTB 67.92 +/- 5.06 %; TTTA 88.51 +/- 5.52 %) (P=0.0173). The mean change in cranial position was also significantly different between the two groups (PTB -8.30 +/- 1.45 %; TTTA 6.83 +/- 0.60) (P=0.0001).
There were no significant differences between the two groups in peak load to failure (PTB 1448.04 +/- 121.54 N; TTTA 1597.09 +/- 43.81 N) (P=0.4541), energy to failure (PTB 15013.69 +/- 2719.37 N mm; TTTA 17314.24 +/- 887.29 N mm) (P=0.646), or stiffness (PTB 102.84 +/- 4.67 N/mm; TTTA 92.93 +/- 4.84 N/mm) (P=0.2716).

All PTB repairs failed by gradual untwisting of the wire and bending of the pins. 4/6 TTTA repairs failed by fracture of the TT through the fork holes. 2/6 TTTA suffered tibial diaphyseal fractures; 1 was excluded from analysis as a force-displacement curve could not be generated.

Discussion

These results show TTTA as an alternative to PTB for lateralisation of the TT. Greater lateralisation was seen with the TTTA, although there was no difference in load to failure or stiffness, so our second hypothesis must be rejected. However, the single load-to-failure testing utilised in this testing does not represent physiological loading of the implants or resistance to cyclic loads. It seems likely that the greater support of the osteotomised fragment with TTTA may help resist cyclic loading, consistent with the lack of implant failures seen in Yeadon’s study (2011).3

The tibial tuberosity was significantly advanced with the TTTA as compared to the PTB as expected. Advancement of the TT has been demonstrated to reduce retropatellar force by approximately 20%, which has the theoretical benefit of reducing retropatellar pain associated with patellar cartilage damage.6 The clinical importance of femoropatellar arthritis is uncertain in canine patients with MPL.

Alternatively, retropatellar force may be important in stabilising the patella, thus reduction in this force may predispose to relaxation. The contribution of retropatellar force to overall stability of the femoropatellar joint has not been elucidated, and further biomechanical testing is required.

In conclusion, we have shown that using a TTA plate system with titanium spacers is more effective at lateralisation of the TT, and this is of comparable biomechanical strength to the standard technique of pin and tension band wire fixation under a single load to failure. The influence of concurrent advancement of the TT requires further investigation.

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