MICROMOTION OF TIBIAL TURBECLE OSTEOTOMIES

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INTRODUCTION:

To avoid transecting and weakening the quadriceps muscle group, the tibial tubercle osteotomy can be used to obtain adequate anterior exposure of the knee [1] in primary and revision total knee arthroplasty. Revision surgery of long cemented firmly fixed tibial trays can also require a tibial tubercle osteotomy, not only to facilitate the exposure, but to allow for the removal of the cement. This procedure is often used with patients with a limited arc of motion (<60 degrees) [2].

The osteotomy has been popularised by Whiteside [1] who described transosseous wiring to secure the osteotomy following joint reconstruction. A variety of fixation techniques can be used for fixation of tibial tubercle osteotomies. Inadequate fixation has the potential to alter the mechanics of the quadriceps mechanism by altering the insertion site of the patella tendon on the proximal tibia. Excessive micromotion at the healing bone interface may also delay primary bone healing. The current study investigated the micromotion of three tibial tubercle osteotomy fixation techniques in a human cadaveric tibial model.

METHODS:

Five centimeter long tibial tubercle osteotomies were performed in 9 cadaveric tibias (mean age 58 years) (obtained under UAGA) (Fig 1.). The osteotomies created were parallel to the long bone axis of the tibia using a sagittal saw. The osteotomies were fixed sequentially using circumferential Dall- Miles Cables (Howmedica, Rutherford, NJ), transosseous wires (Zimmer, Warsaw, IN) and lastly screws.

Figure 1.

Testing was performed using a servo-hydraulic testing machine (MTS Systems, Min, MN). The patella and proximal tibia were fixed in a custom jig. A sinusoidal waveform applied 200 N load applied parallel to the long axis of the patellar tendon. A loading ratio R = 0.1 was used for all testing. Micromotion was measured at the osteotomy using a laser optical sensors (MEL, Germany) on the osteotomy bone block as well as a reference point on the tibia continuously for 200 cycles. Data was reduced to obtain maximum micromotion at the osteotomy interface.

Statistical analysis (SPSS inc, Chicago, IL) was performed using a repeated measures ANOVA followed by a Tukey Honest Significant post hoc test.

RESULTS:

No specimens failed during the dynamic testing regime. Figure 2 presents the data for the micromotion at the osteotomy interface. Fixation with wires displayed the highest amount of motion (170 microns) at the interface that was greater than cable and screw fixation (p<0.05). The cable and screw fixation technique displayed similar micromotion (~ 100 microns) at the osteotomy site and were not statistically different.

DISCUSSION:

Excessive micromotion at the healing bone interface may compromise bony union and alter patellofemoral mechanics in revision knee arthroplasty. To date, the limits of micromotion at the tibial tubercle have not been defined but stability at the interface is vital for primary bone healing. A 200 N sinusoidal loading with an R = 0.1 was chosen based on patellofemoral tracking studies. Micromotion does occur at the bone interface following tibial tubercle osteotomy fixation and is dependent on technique.

While cables and screws fixation displayed the least amount of motion at the interface (approximately 100 microns) care needs to be considered with these techniques. Possible damage to posterior soft tissue structures with cables may be of concern while the use of screws can interface with the keel of a long stemmed tibial tray. Clinically, the use of wires has been successful. This may reflect small loads applied through the patellar tendon in-vivo as well as surgical technique in preparing the defect.

Furthermore, the large surface area available for healing in-vivo with such osteotomies may play an important role in healing in the presence of some micromotion at the osteotomy interface. This study is limited in that we did not incorporate a slope in the osteotomy relative to the tibia, which could decrease the micromotion in all techniques. However, the study performed does provide a relative comparison across the 3 techniques performed.

REFERENCES: