Methods

On fatigue strength were examined. With a modified thread pattern, for locking of a 6 mm ILN. The diameter of the bone increases from the diaphyseal to the metaphyseal region of bone. In addition, screws are often eccentrically loaded in the metaphyseal regions of bone due to the curvilinear nature of some long bones.

The purpose of this study was to test the fatigue life and pushout strength of 2.7 mm cortical bone screws, as well as a prototype screw with a modified thread pattern, for locking of a 6 mm ILN. The effects of bone diameter, eccentric loading, and screw core diameter on fatigue strength were examined.

Using 2.7 mm cortical bone screws, the prototype locking screw was placed in the metaphysis of a cadaveric human femur. The 2.0 mm holes were tapped and filled with 2.7 mm cortical screws; the 2.7 mm holes were filled with the prototype locking screw. Pushout tests were performed on a servohydraulic materials testing system (858 Bionix, MTS Systems, Eden Prairie, MN) under displacement control at 0.1 mm/sec until failure. Data were examined with a Student’s t-test; a p value less than 0.05 was considered statistically significant.

Results

An increase in the diameter of the aluminum tubing from 19 mm to 31.8 mm resulted in a significant decrease in the number of cycles to failure (761,215 ± 239,853 and 16,941 ± 2,829, respectively). Eccentric loading of the screw resulted in a significant increase in the number of cycles to failure (16,941 ± 2,829 and 43,068 ± 14,073, respectively).

None of the prototype screws failed with 2.5 million cycles of loading. The pushout strength of the 2.7 mm cortical bone screw was significantly greater than the prototype locking screw (2,774 N ± 417 N and 608 N ± 322 N, respectively).

Discussion

Increasing the diameter of the tubing increased the maximum deflection and moment of the screw, which should cause crack initiation to occur sooner and crack propagation to progress more rapidly, resulting in a shorter fatigue life. In addition, increasing the maximum deflection of the screw resulted in screw failure by deformation without fracture in Groups 2 and 3. Eccentric loading of the screw caused decreased deflection and total moment of the screw, resulting in a longer fatigue life. The results of this study indicate that the fatigue life of a locking screw centrally loaded in the metaphyseal region of bone may be significantly shorter than in the diaphysis. Eccentric loading of the locking screw in the metaphysis may help to improve its fatigue life.

The fatigue life of a screw is primarily determined by core diameter; screws with a larger core diameter have a longer fatigue life. The absence of threads where the screw contacts the ILN hole has been reported to double the fatigue life [2]. In this study, the prototype locking screw had a fatigue life that was over 140 times that of the 2.7 mm cortical screw.

Screw threads are important in preventing locking screws from migrating out of the bone during fracture healing. The pushout strength of a screw is dependent upon thread diameter, profile, pitch, depth, and length. In this study the 2.7 mm cortical bone screw had a greater pushout strength than the monocortical prototype locking screw by a factor of 4. However, since locking screw migration is less of a clinical problem than screw failure, fatigue life may be a more important consideration than pushout strength when selecting an appropriate locking screw.

References


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