THE EFFECT OF CORTICAL STRUT GRAFTING ON FEMORAL STRAIN IN CEMENTED AND NONCEMENTED HIP ARTHROPLASTY

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Introduction:
One possible cause of thigh pain following noncemented total hip arthroplasty is increased stress in the mid-portio of the femur. Anterolateral placement of a cortical strut allograft has successfully alleviated thigh pain in symptomatic patients. The purpose of this study was to show experimentally whether the surface strains on the femur are altered by the presence of cemented and noncemented implants and by the addition of the strut graft. Cemented implants, which typically are not associated with thigh pain, were included as a control group.

Methods:
Sixteen uniaxial strain gages were attached to matched pairs of cadaver femurs and tested under three conditions: intact, with hip prosthesis, and with a 12 cm anterolateral cortical strut graft. The right femurs were instrumented with cobalt-chrome (Howmedica Osteontics ODC, size range #6-7) cemented hip prostheses while the left femurs were instrumented with cobalt-chrome (Howmedica Osteontics Meridian, size range #14-16) noncemented hip prostheses. The femurs were tested using a single-leg stance model shown in Figure 1. Several investigators have successfully used a single-leg stance model to study femur surface strain. Strain was measured using uniaxial strain gages (Measurements Group CEA-06-062UW-120) connected to a strain conditioning unit (National Instruments SCXI Model 1121) in a one-half bridge configuration to provide temperature compensation. Twelve strain gages were attached to the femur in the midshaft region at three levels, -2cm, 0cm, and +2cm relative to the implant tip. The four gages at each level were evenly distributed circumferentially. Additional strain gages were placed 12 cm above and below the implant tip on the medial and lateral surfaces. Each femur was loaded through the proximal fixture until the distal load cell registered a 360 N load. The custom fixture simulates physiologic single leg stance loading of the hip joint by accounting for the body weight offset balanced by abductor and ilio-tibial forces. Since previous testing has shown a strong linear relationship between simulated stance load level and measured surface strain, the 360 N load level was chosen to reduce risk of specimen fracture. Each femur was tested three times to determine data repeatability.

Results:
Following implantation of the prostheses the surface strain at the proximal lateral gage site decreased 12-27% for the cemented implant and 84-98% for the noncemented implant. The surface strain at the proximal medial gage site decreased 94-96% for the cemented implant and 70-99% for the noncemented implant. Corresponding to the region of reported thigh pain, the tensile strain at the midshaft anterolateral gage sites increased 5-18%. With the addition of the strut graft the strain at the same sites decreased 8-35%. The maximum midshaft tensile strain ranged from 900 to 1600 microstrain with an uncertainty of 4 to 60 microstrain.

Discussion:
Following implantation, stress shielding was observed in the metaphyseal region. The addition of the strut graft increases the cross-sectional moment of inertia thereby decreasing posteromedial/anterolateral surface strain. Since the results in the region of reported thigh pain were similar for the noncemented and cemented implants, the source of thigh pain is unlikely due to surface strain.

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References:

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