Title: 11148—Scratch fit at stem implantation predicts mechanical implant stability

Authors: Antoinette Lindberg, MD antoinette.lindberg@seattlechildrens.org; Jedediah K. White, BS jedwhite@uw.edu; Stephanie E. W. Punt, BS stepunt@uw.edu; Randal P. Ching, PhD rc@uw.edu; Ernest U. Conrad, III, MD chappie.conrad@seattlechildrens.org
University of Washington, Seattle, WA USA

Background:
Aseptic loosening contributes significantly to oncologic implant failures with multiple large North American published clinical reviews describing implant aseptic loosening incidence rates of 15-30%.

Questions/Purpose:
Uncemented pressfit fixation for oncology implants have demonstrated significant reduction in the incidence of aseptic loosening but the surgical technique for adequate/pressfit implantation has not been previously described.

Patients and Methods:
The current biomechanical study has investigated a method of assessing the stability of oncologic uncemented femoral stem implantation following distal femoral resection. The study evaluated femoral cadaveric specimens treated with a 13cm distal femoral resection. Femoral stem implantation was a two-step process that occurred after femoral reaming with stem size selection by X-ray assessment of canal diameter. Use of a hand-held spring loaded "press" resulted in manual stem GMRS Stryker oncologic stem (12.5cm) implantation with a 222N (50lbs) insertion force. The resulting stem insertion point was measured as the "scratch fit" distance between the stem collar and the femoral osteotomy line. Initial "scratch fit" goals were 1-4 cm and femoral reaming diameter was varied to achieve different (1-4 cm) "scratch fit" preliminary insertion points. After a 222 N insertion point was achieved, the implant was then manually impacted into the femur until the collar was in contact with the cut surface of the femur. The femoral specimen and implant were then potted and evaluated for implant stability. All stems were tested in torsion until failure on a multiaxis test system, and femoral stem kinematics were captured using a Vicon motion capture system (Vicon, Los Angeles, CA).. Kinematic data was processed in Matlab (Mathworks, Natick, MA) and statistical analyses were perform using R (R Foundation).

Results:
Axial (torsional) moment vs. relative angular displacement between stem and femur was the primary outcome evaluated (Table 1). Correlations were calculated between peak torque (at 150 microns) and the initial "scratch fit" stem insertion point. A correlation was confirmed between peak torque and scratch fit lengths (r^2=0.64) (Figure 1), and improved peak torque correlations were found when separated by stem diameter (Figure 2). Larger (3-4 cm) scratch fit insertion points are expected to correlate with greater implant stability and a lower incidence of clinical aseptic loosening.

Conclusions:
Identifying potential factors that may correlate with implant stability may overall improve clinical aseptic loosening rates in the uncemented distal femoral stem.
Evidence Level: II

Table 1: Specimen peak torque and “scratch fit”

Specimen ID	Implant Size	Scratch Fit (mm)	Moment (Nm)	
			at 150µm	Peak
04974	11	46	29.91	38.85
04988	13	29	16.72	27.23
05372	14	44	15.05	45.67
05459	15	21	15.13	22.00
05518	14	17	12.00	15.76
05519	13	46	11.42	57.47
05546	13	17	08.32	11.53
05603	15	26	12.32	49.56
05890	13	37	12.46	47.67
40288	15	35	10.12	53.68
40307	14	27	08.90	20.42
40310	15	07	09.26	13.26

Figure 1: Peak torque (Nm) versus scratch fit (mm)

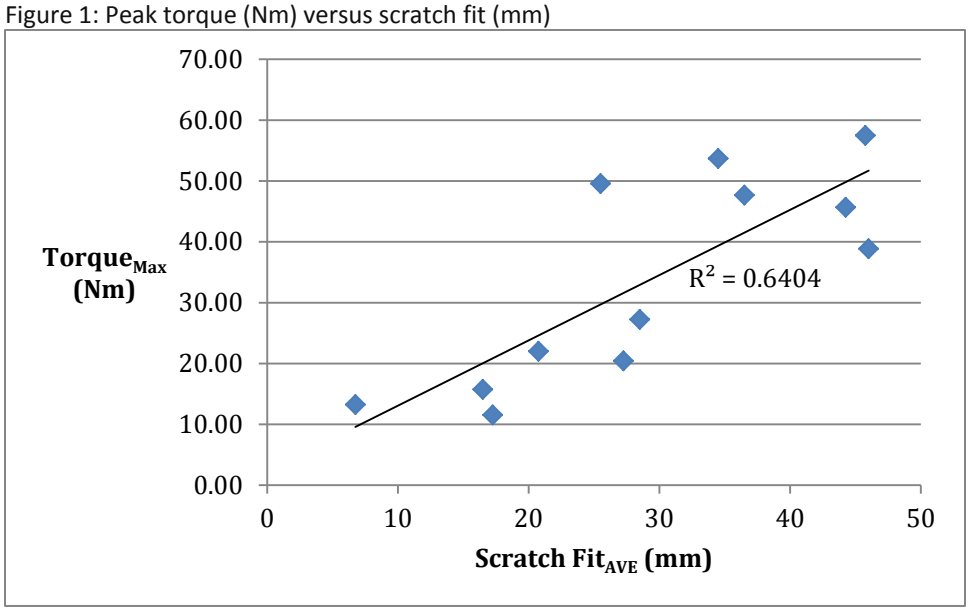
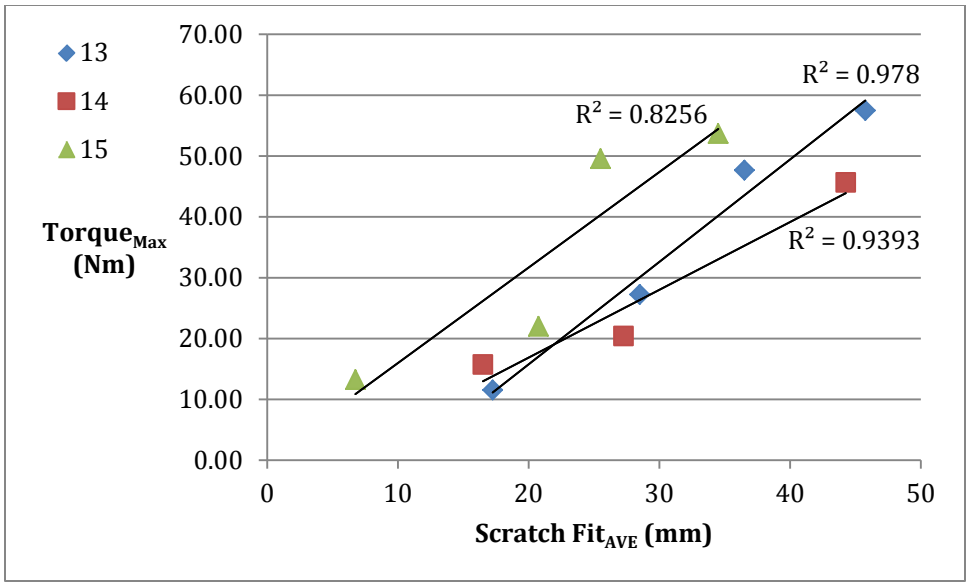


Figure 2: Peak torque (Nm) versus scratch fit (mm) by stem size


13
14
15
Torque$_{Max}$ (Nm)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
10
20
30
40
50
Scratch Fit$_{AVE}$ (mm)
R^2 = 0.978
R^2 = 0.8256
R^2 = 0.9393