POSTOPERATIVE LEG OFFSET DISCREPANCY INFLUENCES SOFT TISSUE TENSION IN TOTAL HIP ARTHROPLASTY

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INTRODUCTION

Inappropriate soft tissue tension around an artificial hip is regarded as one cause of dislocation or abductor muscle weakness, but what actually constitutes an appropriate degree of soft tissue tension is unclear (Charles MN 2005, Bourne RB 2002). One method of assessing soft tissue tension that is generally used during surgery is the leg traction test, or the shuck test, in which traction is applied to the leg in the distal direction, and the distance moved by the femoral head is observed (Charnley J 1979). The shuck test is performed to evaluate soft tissue tension after a trial implant has been set in place, after which the final decision on implant size is made. Surgeons are dedicated to balance the soft tissue tension and leg length and offset. Some emphasized the importance of restoration of leg offset to optimize soft tissue tension in THA, while it is unclear what factors determine soft tissue tension around artificial hip joints. The purpose of the present study was to assess how postoperative leg offset influence the soft tissue tension around artificial hip joints using a computer navigation system.

MATERIALS AND METHODS

The subjects were 89 consecutive patients who underwent mini-incision cementless THA with the use of a computer tomography-based navigation system (CT-based Hip Navigation Version 1.1, Stryker Navigation Freiburg, Germany) on a lateral position. 57 patients underwent THA through mini-incision posterior approach and 32 patients through antero-lateral approach. Cementless anatomical stems (CentPillar; Stryker) or cementless tapered stem (Accolade TMZF; Stryker) were used. Cementless cups with polyethylene liners without elevated rims (Trident and Crossfire; Stryker) were used in all patients.

Preoperative CT images of each patient were taken using a helical CT scanner (HiSpeed Advantage, GE Medical Systems, Milwaukee, USA) from the level of the superior anterior iliac spine of the pelvis to the level of the femoral condyles. Position and orientation of the cup and the stem was planned using the navigation system. The pelvic coordinates were defined as follows; the axial reference was referred to the anterior pelvic plane (APP) through the superior anterior iliac spines and the pubic tubercles; and a line through the bottoms of the bilateral ischia was used to adjust the horizontal axis; and the anterior-posterior axis was tilted according to the tilt of APP in supine on the CT table. The femoral coordinates were defined as follows; the vertical axis was referred to a line through the trochanteric fossa and knee center; and the coronal plane was parallel to the posterior condilar plane through the posterior prominent of the greater trochanter and the posterior femoral condyles.

THA was performed on a lateral position under general anesthesia. After implantation of the cup and the stem, their position and orientation were measured using the navigation

with reference to the above-mentioned pelvic and femoral coordinate systems. The amount of leg lengthening and lateralization, and postoperative leg length and offset discrepancy were also measured using the navigation. After reduction of the artificial hip joints, an L-shaped metal plate fitted with a hook was fastened with inelastic bandages from the lower thigh to the sole of the foot, and traction was applied to a traction gauge (FB 500N; IMADA CO., LTD, Aichi, Japan) attached to the hook. Traction amounting to 40%, of body weight was applied with the joint positioned at 0º, 15º, 30º, and 45º of flexion, and the distance of separation between the head and the cup was measured. The joint was adjusted so that the angle of internal/external rotation was kept within 5º.

We assessed the following 13 possible factors which might influence the head/cup separation during lower leg traction using step-wise multiple regression analysis: age, gender, approach, diagnosis, preoperative range of motion, the amount of leg lengthening and lateralization, postoperative leg length and offset discrepancies, and stem anteversion. Preoperative range of motion was recorded in the four directions, flexion, extension, abduction, and adduction.

RESULTS

The distance of head/cup separation during lower leg traction differed significantly for different angles of flexion, with the greatest distance moved at 15^{o} of flexion (Figure 1) Stepwise multiple regression analysis showed that postoperative leg offset discrepancy were correlated negatively with the distance of cup/head separation at 0^{o}, 15^{o} and 30^{o} of flexion. The amount of leg lengthening were correlated negatively with the distance of cup/head separation at 0^{o} and 30^{o} of flexion ,while postoperative leg length discrepancy did not correlated with the distance of cup/head separation at any flexion positions. Antero-lateral approach was correlated positively with the distance of cup/head separation at 0^{o} and 15^{o} of flexion. Preoperative extension ROM were correlated positively with the distance of cup/head separation at 0^{o} of flexion and preoperative ROM in abduction was positively correlated with the distance of cup/ head separation at 15^{o} of flexion. Female gender was positively correlated with the distance of cup/ head separation at 30^{o} of flexion. No variables were detected to influence the distance of cup/ head separation at 45^{o} of flexion.

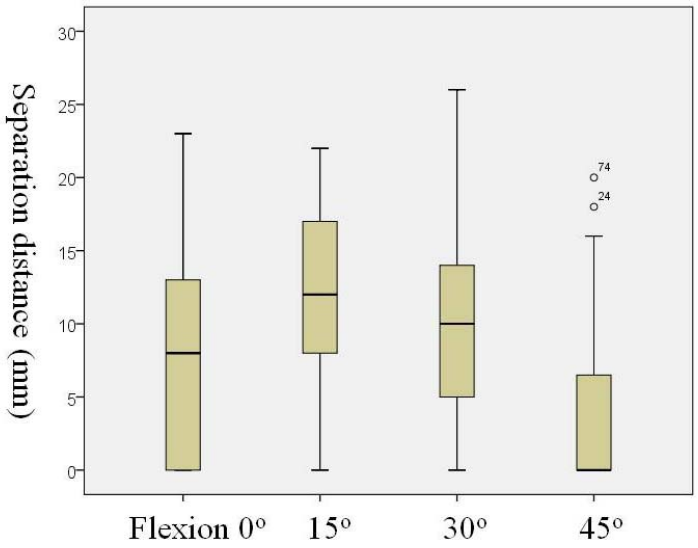

Figure 1. Relationship between the flexion angle of hip joints and the distance of cup/head separation.

	Flexion 0°		Flexion 15°		Flexion 30°	
Variables	β	p-value	B	p-value	β	p-value
Post-op leg offset discrepancy	-0.16	0.04	-0.24	0.014	-0.31	0.002
The amount of leg lengthening	-0.27	0.003	-	-	-0.23	0.021
Anterolateral approach	0.38	<0.001	0.35	<0.001	-	-
Pre-op ROM in extension	0.29	0.001	-	-	-	-
Pre-op ROM in abduction	-	-	0.21	0.028	-	-
Female	-	-	-	-	0.24	0.016
Overall						
r^2	0.49		0.26		0.21	
Adjusted r^2	0.47		0.23		0.18	
p-value	<0.001		<0.001		<0.001	

Table 1 Stepwise multiple regression analysis of the influence of independent variables on soft tissue tension around artificial hip joints

DISCUSSION

Restoration of the femoral offset after THA is reported to be important to obtain good abduction muscle strength and gait function (Tezuka T 2014, Sariali E 2014). It was unclear how postoperative leg offset influence the soft tissue tension around artificial hip joints. In the present study post operative leg offset discrepancy influenced significantly the distance of cup/head separation during distal leg traction at a wider range of flexion. This indicated that it is important to restore global leg offset to obtain appropriate soft tissue tension in THA.

REFERENCES

1. Charles MN, Bourne RB, Davey JR, et al. Soft-tissue balancing of the hip: the role of femoral offset restoration. Instr Course Lect. 2005;54:131-41.

2. Bourne RB, Rorabeck CH. Soft tissue balancing: the hip. J Arthroplasty. 2002;17:17-22.

3. Charnley J. Low friction arthroplasty of the hip. New York: Springer-Verlag; 1979

4. Tezuka T, Inaba Y, Kobayashi N, Ike H, Kubota S, Kawamura M, Saito T. Effects of hip joint center location and femoral offset on abductor muscle strength after total hip arthroplasty. Mod Rheumatol. 2014 Dec 22:1-7.

5. Sariali E, Klouche S, Mouttet A, Pascal-Moussellard H. The effect of femoral offset modification on gait after total hip arthroplasty. Acta Orthop. 2014;85(2):123-7.

DISCLOSURES

None