Evaluation of the relationship between muscle tendon preservation and gait analysis in total hip arthroplasty

Ryuichi Sato[1,2], Hajime Sugiyama[1,2], Yohei Matsushita[1,2], Takuya Maeda[1,2], Hisahiro Tonotsuka[1,2], Mitsuru Saito[2]
[1]Department of Orthopaedic Surgery, Kanagawa Rehabilitation Hospital, Kanagawa, 243-0121, Japan
[2]Department of Orthopaedic Surgery, Jikei University School of Medicine, Tokyo, 105-8461, Japan
Email of Presenting Author: korisato5151@yahoo.co.jp

Disclosures: Ryuichi Sato (N), Hajime Sugiyama (N), Yohei Matsushita (N), Takuya Maeda (N), Hisahiro Tonotsuka (N), Mitsuru Saito (N)

INTRODUCTION: Minimally invasive surgery (MIS) for total hip arthroplasty (THA) has been widely performed since the 2000s, and early functional recovery after THA has been reported. Gait analysis is a functional evaluation method that is used after THA. In a previous report, a prospective study comparing MIS-THA with a wound length of 10 cm or less with conventional THA showed no significant difference in improvement in walking ability 6 weeks postoperatively. The conjoined tendon-preserving posterior approach (CPP) is a posterior MIS-THA technique that reduces muscle-tendon invasion. This approach preserves the piriformis muscle, conjoined tendon, and the ischiofemoral ligament without dissection. We hypothesized that a reduction in muscle-tendon dissection would facilitate early postoperative gait improvement compared to THA using the conventional posterolateral approach. This study aimed to evaluate the effect of muscle preservation on walking ability by comparing THA performed using CPP and the conventional posterolateral approach (PL) using gait analysis.

METHODS: This retrospective cross-sectional study was conducted at a single institution. All procedures involving human participants were conducted in accordance with the ethical standards of the Institutional Research Committee and the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Patients who underwent robotic-arm-assisted THA performed by a single surgeon since January 2021 were included in this study. All patients underwent THA in the lateral recumbent position, mainly PL from January 2021 and CPP from December 2022. The causative disease was hip osteoarthritis in all the patients. Fourteen patients with PL and 12 with CPP were included in the study, and walking ability was measured by gait analysis at preoperative and 3-month postoperative outpatient visits. Bias was eliminated by matching the age, height, and weight of the two groups using propensity score matching. Finally, 10 participants from each group were selected. Gait analysis was performed using a VICON System plug-in gate and floor-resisting force meter. One sensor was attached to each shoulder and one to the back, and 10 sensors per side were attached to the pelvis, thighs, lower legs, and feet. A floor-resisting force meter was used to determine the swing, stance, one-leg support, and two-leg support phases during the stance phase. All patients were able to walk for approximately 10 min without a cane. The following parameters were evaluated during free walking: walking speed (cm/sec), walking cycle (sec), step length (cm) on the operative and nonoperative side, cadence (steps/min), floor reaction force (% of body weight) on the operative and nonoperative side, and hip motion angle (degree) on the operative and nonoperative side. Statistical analysis was performed using the Mann-Whitney U test. Differences were considered statistically significant at $P < 0.05$.

RESULTS: The mean age of patients in both group was 66.9 years. Preoperative and 3-month postoperative gait analysis data are shown in Table 1. Preoperative gait analysis data showed no significant differences between the two groups in any of the gait parameters, except for the hip motion angle on the non-operative side. Comparing the gait analysis results at 3 months postoperatively between the two groups, the mean gait speed and mean step length showed no statistically significant difference. On the other hand, the mean walking cycle was 1.04 sec for CPP and 1.15 sec for PL, significantly shorter for CCP, and the cadence was 115.7 steps/min for CPP and 105.3 steps/min for PL, significantly higher for CCP. There were no significant differences in floor reaction force or hip angle range of motion between the two groups.

DISCUSSION: CPP is a posterior MIS-THA that preserves the piriformis muscle, conjoined tendon, and ischiofemoral ligament without dissection. However, there have been no reports on functional recovery after THA. The results of this study showed that the walking cycle and cadence improved compared to PL. Preservation of the core muscles is thought to affect the number of steps per unit time. Step length was almost the same in both groups, and walking speed tended to be faster in the CPP group, although there was no significant difference between the two groups. Elderly individuals maintain dynamic balance by decreasing their step length. Therefore, improvement in cadence is necessary to improve walking speed, and CPP may improve walking speed to a greater extent. The limitations of this study include the small number of patients and short follow-up period. We plan to evaluate the extent of the improvement in gait speed by increasing the number of patients with a longer follow-up period.

SIGNIFICANCE/CLINICAL RELEVANCE: The posterior approach, with a reduction in muscle-tendon dissection, may improve walking ability more than the conventional approach.

Table.1 Variables of gate analysis and floor reaction force

	preoperative			3 months after surgery		
	CPP	PL	p value	CPP	PL	p value
walking speed (cm/sec)	91.9 ± 24.4	96.4 ± 19.0	0.36	110.8 ± 16.2	102.2 ± 19.4	0.33
walking cycle (sec)	1.1 ± 0.1	1.2 ± 0.2	0.14	1.0 ± 0.1	1.2 ± 0.1	**< 0.01**
cadence (steps/min)	110.6 ± 10.8	104.3 ± 12.7	0.23	115.7 ± 6.2	105.3 ± 6.4	**< 0.01**
step length on the operative side (cm)	49.0 ± 9.6	55.6 ± 7.1	0.19	57.4 ± 7.6	57.6 ± 10.0	0.76
step length on the non-operative side (cm)	49.4 ± 9.1	54.5 ± 6.9	0.19	57.5 ± 7.2	58.4 ± 8.3	0.94
floor reaction force at the initial contact on the operative side (% of body weight)	104.8 ± 8.8	100.7 ± 7.1	0.55	106.8 ± 6.5	105.0 ± 4.6	0.60
floor reaction force at the initial contact on the non-operative side (% of body weight)	108.7 ± 12.5	104.7 ± 10.5	0.76	110.0 ± 7.6	107.4 ± 8.8	0.34
floor reaction force at the toe off on the operative side (% of body weight)	104.4 ± 4.9	102.7 ± 7.2	0.76	106.4 ± 4.8	104.4 ± 4.8	0.43
floor reaction force at the toe off on the non-operative side (% of body weight)	104.9 ± 5.8	104.2 ± 8.5	1	107.5 ± 6.1	106.0 ± 6.0	0.60
hip motion angle on the operative side (degree)	30.3 ± 6.5	34.2 ± 7.8	0.22	36.1 ± 5.6	37.6 ± 6.9	0.50
hip motion angle on the non-operative side (degree)	32.9 ± 6.1	39.5 ± 7.6	**0.04**	40.0 ± 7.2	41.8 ± 6.7	0.65

Mann-Whitney U test.
Boldface numbers indicate significant differences.
CPP: conjoined tendon-preserving posterior; PL: posterolateral