ORIGINAL PAPER

Nagoya J. Med. Sci. **77**. 51 ~ 57, 2015

SURGICAL SKILLS TRAINING FOR PRIMARY TOTAL HIP ARTHROPLASTY

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ABSTRACT

A total of 483 hips treated by primary total hip arthroplasty (THA) were investigated to evaluate the surgical skill of the performing surgeon. Surgical trainees operated on 259 hips and instructors on 224 hips. The average age of the patients at the time of THA in the trainee and instructor group was 61.9 and 60.8 years old, respectively. The average follow-up duration was 5.1 years. The operative time in the trainee group and instructor group was 87.0 and 73.1 min, respectively (p=0.031). Complications were noted in 11 hips (3.5%) in the trainee group; acetabular fracture, 3 hips; dislocation, 3 hips; femoral artery lacerations that needed repair surgery, 2 hips; sciatic nerve palsy, 2 hips; and skin necrosis, 1 hip. Complication were noted in three hips (1.3%) in the instructor group; femoral fracture, 1 hip; acetabular fracture, 1 hip; dislocation, 1 hip. Complication rate in the trainee group was higher than in the instructor group. The monitored quality of the surgeries performed by trainees and instructors was not significantly different. Poor quality was identified in 14 hips in the trainee group and 6 hips in instructor group. No significant difference was found in the hip score between the trainees and instructors before and after surgery. Revision arthroplasty was defined as the end-point for primary THA. Kaplan-Meier survivorship at 5 years after primary THA was 97.2% in trainee group and 97.3% in the instructor group. Short-term clinical and radiographic results of primary THA in the trainee and instructor groups were considered safe and satisfactory.

Key Words: Total hip arthroplasty, osteoarthritis of the hip, technical skill, education, complication

INTRODUCTION

Total hip arthroplasty (THA) is one of most effective surgical procedures for patients with end-stage osteoarthritis of the hip. More than one million primary THA procedure are performed annually in the world. However, longevity of THA is a critical problem for young and active patients. Many authors reported excellent long-term results after THA.[1,2] A study of Swedish national registry reported 10-year survival rate for THA of 94.8% and 87.7% after primary cemented and primary cementless THA, respectively.[3] Many studies have shown that high volume hospitals have lower mortality rates and better clinical outcomes.[4-11]

Both teaching hospitals and surgical specialty hospitals teach young orthopedic trainees the theory and technical skills required for THA. Since trainees are new to performing surgeries, they

Received: February 27, 2014; accepted: August 21, 2014

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should be supervised by experienced and skilled surgeons.[12] This practice helps not only to avoid possible serious risks for patients but also to impart effective education regarding surgical skills. The instructor can immediately and appropriately solve any difficult situation experienced by the trainee during a surgical procedure. These systems minimize any potential risk of complications, and provide an effective educational system for trainees.

The relationship between a surgeon's case volume and the risk of complications after THA is important.[13] One group studied 37,881 peoples who underwent their first primary THA and determined that surgeons should perform at least 35 THA procedures annually to reduce the risk of surgical complications.

Woolson *et al.* reported similar clinical results for THA in teaching hospital with resident trainee and a specialty hospital with no trainees.[14] Whether teaching hospitals have better outcomes for THA than non-teaching hospitals is remains controversial. However, technical failures during surgery are likely to increase the revision rate after THA.[8, 15-18]

Monitoring of the quality of surgical skill is very important for trainee education. Postoperative radiographic findings such as socket and stem alignments as well as fixation pattern can significantly influence clinical results.[18] In the United States, lower inpatient mortality after THA has been reported in high volume hospitals.[19]

The rate of complications and the quality of THA can easily be used to evaluate the technical skills of surgeons. In orthopedic surgery, the cumulative summation statistical test (CUSUM test) has been used to evaluate the quality of surgical skill after total knee arthroplasty.[17,20,21] If there are many complications, the CUSUM test is effective.

The purpose of this investigation was to clarify the following four points regarding the technical skills of trainees and the education system for surgical skills for primary THA. First, operative time and blood loss during surgery were compared between trainees and instructors. Second, quality monitoring according to Biau *et al.*[18] and the incidence of three selected complications; large vessel laceration, nerve palsy, and deep infection, were compared between trainees and instructors. Third, clinical hip scores (the Japanese Orthopaedic Association hip score were compared between trainees and instructors.[22] Fourth, survival according to the Kaplan-Meier method with the endpoint defined as revision surgery was compared between trainees and instructors.

PATIENTS AND METHODS

We established an educational system for surgical skill training at the Department of Orthopedics Nagoya University Hospital in 1998 to provide specialist training for hip surgery. Trainees had to perform a minimum of 100 hip operations to acquire adequate knowledge and surgical technical expertise for primary THA. During the 5 years of training, skilled instructors had to provide supervision. Trainees also had to learn the surgical techniques required for eccentric rotational acetabular osteotomy according to Hasegawa *et al.* for adult hip dysplasia.[23,24]

The Ethics Committee of our institutions approved this study, and all patients provided informed and consent for this study.

Between 2006 and 2010, 589 primary THA procedures performed in two hip surgery training institutions, Nagoya University hospital and Aichiken Saiseikai hospital, were included in this study (Figure 1). Seven trainees and two instructors performed all operations. Data on complication were collected from hospital records. The two instructors had experience of performing more than 1000 THA procedures with sufficient expertise to teach the theory and techniques for both primary and revision THA. The trainees were orthopedic surgeons receiving education on the surgical techniques of primary THA to be a hip surgery specialist. Trainees performed between

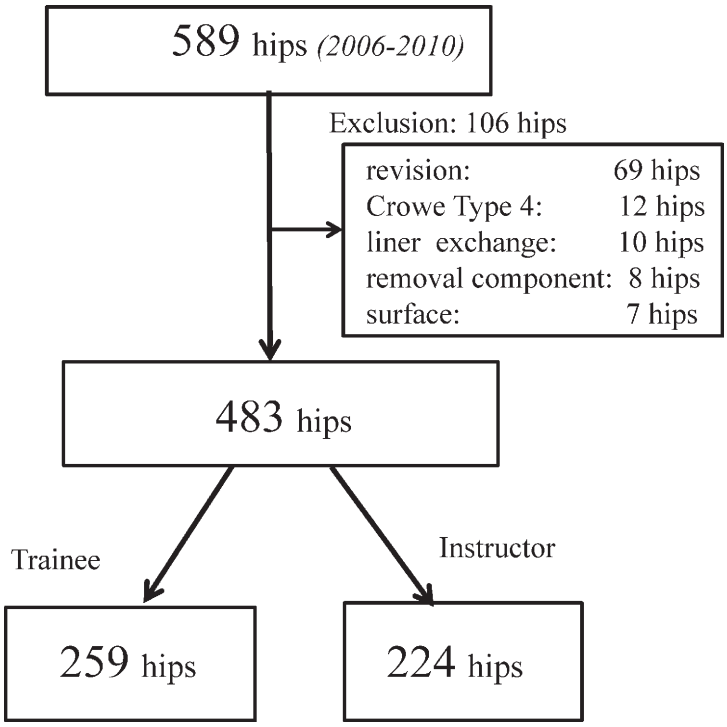

Fig. 1 Patients data

0 to 100 primary THA procedures during their training.

One hundred and six hips were excluded from this study: 69 because of revision THA, 12 because of complete dislocation (Crowe type 4), 10 because of socket liner revision, 8 because of component removal of any component without implantation because of deep infection, and 7 because of surface replacement. All patients were followed up three years or more.

A total of 483 hips were included in this study. Trainees operated on 259 hips (207 with cementless fixation), and instructors operated on 224 hips (196 with cementless fixation). Trainees performed a significantly lower number of cementless primary THA procedures than the instructors ($p = 0.013$). All operations were performed via a posterior approach and tight repair of the capsule and short rotators was performed in all cases. The average duration of follow-up was 5.1years (range, 3–7 years).

Statistical analysis was performed using the Student-t test, chi-square test, and Fisher's exact test. A p value of <0.05 was considered statistically significant.

RESULTS

The average age of the patients in the trainees and instructor groups at the time of primary THA were 61.9 ± 11.7 years and 60.8 ± 11.6 years, respectively (Table 1). The operative time for trainees and instructors were 87.0 ± 28.3 min and 73.1 ± 19.6 min, respectively (Table 2). The operative time was significantly shorter for instructors than for trainees ($p = 0.031$). Blood loss during surgery was 293 ± 256g for trainees and 271 ± 176g for instructors.

Table 1. Patients back ground

	Trainee	Instructor
Age (mean ± SD)	61.9±11.7	59.8±11.6
Operative time (mean ± SD)	87.0±28.3	73.1±19.6*
Blood loss (g) (mean ± SD)	293±256	271±176

**p=0.031*

Table 2. Complications of primary THA

	Trainee	Instructor
dislocation	3	1
acetabular fracture	3	1
sciatic nerve palsy	2	0
femoral artery injury	2	0
skin necrosis	1	0
femoral fracture	0	1
total	11	3

Incidence of total complication (*p=0.099*)
Fisher's exact test

Surgical complications occurred in 11 hips (3.5%) during surgeries performed by trainees. The complications included two cases of femoral artery lacerations requiring repair by a vascular surgeon; two cases of sciatic nerve palsy, three acetabular facture, three hip dislocations, and one case of skin necrosis. Surgical complications occurred in three hips (1.3%) during surgeries performed by instructors. These included a femoral facture, and an acetabular facture, and a dislocation. The complication rate was higher in the trainee group than in the instructor group, but the difference was not significant (p=0.099). Quality monitoring revealed poor quality in 14 hips in the trainee group and in six hips in the instructor group (Table3, and 4), but this difference was also not statistically significant (p=0.171).

In the trainees group the clinical hip score according to the Japanese Orthopedic Association was 58.9 ± 11.7 before surgery and was 94.1 ± 8.6 at final follow-up. In the instructors group the clinical hip score was 57.8 ± 10.6 before surgery and 93.8 ± 8.1 at the final follow-up. The clinical hip scores did not differ significantly between trainees and instructors. Survival rate at 5 years after primary THA according to the Kaplan-Meier method with revision surgery defined as the endpoint were 97.2% (95% confidence interval 94.2–100) for the trainee-performed THA and 99.3% (95%CI: 95.4–100) for instructor-performed THA. This difference in survival between trainees and instructors was not significant.

DISCUSSION

Surgical complications occurred in 11 and 3 hips for which THA was performed by trainees and instructors, respectively. The complication rates was higher in the trainee group but was not significantly different from the instructor group (p = 0.099). Poor quality according to Biau

Table 3. Quality monitoring of primary THA

		Trainee	Instructor
1	Fracture of acetabulum	3	0
2	Femoral fracture	0	1*
3	Leg shortening (1cm<), lengthening 2cm<)	0	0
4	4 degrees or more varus or valgus stem position	0	0
5	Cementing (Barrack C, D=8 Zone or more	0	0
6	Socket inclination (55deg.<, 30deg.>)	2	1
7	Socket anteversion (0deg.>, 30deg.>)	2	1
8	Cement 1mm or more RZ (1 or more Zone) Cementless gap 3mm≧	0	0
9	Dislocation	3	1
10	Death	0	0
11	Large vessel injury	2	0
12	Nerve palsy	2	1
13	Deep infection	0	1*

*same patient; femoral fracture and deep infection

Table 4. Primary THA quality monitoring

	n=259 Trainee	n=224 Instructor
Poor quality	14 (5.4%)	6 (2.7%)

Incidence of poor quality (*p=0.171*)
Fisher's exact test

et al.[18] was identified in 14 hips in the trainees group and in six hips in the instructor group, which was also not statistically significant (Table 3, and 4).

Comparison of complications and the quality of primary THA between hospitals is extremely difficult because of patient attributes. The first question is whether all patients treated with primary THA have similar baseline characteristics. Herickhoff *et al.* reported on surgical candidate selection between surgeons at the same institution in their study of primary THA and total knee arthroplasty.[25] They compared the cases of four surgeons using the short form 36 and the Western Ontario and McMaster Osteoarthritis Index (WOMAC) and found no difference, concluding that similar patients were treated with both primary THA and total knee arthroplasty.

Few studies have monitored the quality of surgical skill. Biau *et al.* reported ten categories of quality evaluation for primary THA (Table 3). We evaluated three complications: large vascular laceration reqiring repair, nerve palsy, and deep infection. Biau *et al.* reported a high rate of poor quality, in 57 of 200 hips (28.5%). In our study, poor quality was noted only in 14 hips (5.4%) in the trainee group and in six hips (2.7%) in the instructor group.

One study has reported on the poor quality of cementing techniques.[18] Another study compared 22 hips with cementing failure within 5 years and 60 hips with good cementing

outcomes after primary THA.[26] The failure rate was 9.5 fold higher for inadequate cementing (Barrack types C [50–99% radiolucency at the cement-bone interface] and D [100% radiolucency or failure] than for a good cement-bone interface. Radiolucency with a cemented stem in Zone 2 produced significantly poor results.

The definition of poor quality has not been well established; for instance, it is uncertain whether shortening by more than 1 cm and lengthening by more than 2 cm indicates discrepancy.[18,27] Similarly, it is uncertain whether varus or valgus stem alignment more than 4 degrees constitutes poor quality. More precise criteria of poor surgical quality are necessary to determine long-term clinical outcomes.

There were several limitations in this study. First, the technical difficulty of individual surgeries was not considered when assessing quality. Patient selection was different between trainees and instructors. Easier cases such as Crowe type I or osteonecrosis of the hip, were operated upon by trainees, and more complicated cases such as high hip dislocation or failed femoral/acetabular osteotomy, were operated on by instructors. Second, trainees performed significantly more cement THAs for educational purposes. However, random selection of difficult hips for the scientific investigation is not only dangerous for the patients, but will also reduce the results when the quality of the surgery is measured.

Short-term Japanese Orthopedic Association hip score for primary THA in trainee group were not significantly different from the instructor group. However, technical problems would influence a longer outcome after primary THA. Long-term follow-up will be needed to establish a better educational system for trainees.

CONCLUSIONS

Operative time in the trainee group was significantly longer than that in the instructor group. Complications rate was higher, but not significantly in the trainee group than in the instructor group. Short-term clinical and radiographic results of primary THA by trainees were found to be safe and satisfactory.

CONFLICT OF INTEREST

Takefumi Amano discloses no financial support or relationship that may pose conflict of interest.

Yukiharu Hasegawa discloses financial support to the Department of Hip and Knee Surgery, Nagoya University Graduate School of Medicine from Stryker Co., Yoshida Hospital, and Nagoya Orthopedic Clinic.

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