Shimane J. Med. Sci., Vol.26 pp.21-25, 2009

Quantitative Measurements of Hip Abductor Muscle Strength After Total Hip Arthroplasty Using the Direct Lateral Approach: Recovery of the Abductor Strength in Total Hip Arthroplasty

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(Received August 28, 2009; Accepted November 10, 2009)

Twelve osteoarthritic female patients with unilateral involvement underwent total hip arthroplasty (THA) using the direct lateral approach (DLA). After discharge, a home program of isometric muscle exercises on both sides of the hip was prescribed for 6 months. Clinical evaluation and measurement of the strength of hip abductor muscles were performed at 6 months, 1 and 2 years postoperatively.

Statistically significant improvement in the Merle d' Aubigné hip score was obtained at 6 months postoperatively, but the recovery of hip abductor muscle strength was slightly delayed. The ratio of peak torque of abductor muscles in the operated hip to that in the non-operated hip was 68.6 ± 31.4% preoperatively and reached 77.8 ± 31.4% at 6 months, 91.5 ± 21.2% at 1 year, and 93.4 ± 20.8% at 2 years postoperatively. Our results indicate that the DLA does not have a deleterious effect on recovery of the abductor muscle strength.

Key words: muscle strength, total hip arthroplasty, surgical approach, muscle exercise

INTRODUCTION

The posterior approach (PA) is the most frequently used approach for total hip arthroplasty (THA), because it has the advantages in the operation time and blood loss. However, Roberts et al. reported that the PA caused a relatively high dislocation rate (1). On the other hand, the direct lateral approach (DLA) introduced by Hardinge (2) offers adequate access for orientation of the implant and a low dislocation rate (3). Criticisms of the DLA that have been raised include an increased incidence of abductor weakness, thought to result from muscle injury, as well as injury to the inferior branches of the superior gluteal nerve.

The purpose of this study is to analyze hip abductor muscle strength quantitatively with a Cybex instrument after THA using the DLA for up to 2 years.

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PATIENTS AND METHODS

Subjects

Twelve consecutive female patients ranged in age from 43 to 79 years (average: 63) were included in this study. All patients suffered from unilateral osteoarthritis of the hip. Patients with intermediate or high dislocation of the hip were excluded from this study. All hips were classified into group I or group II using Crowe's classification (4). Primary THA was performed by one surgeon using the DLA. Protected weight bearing was advised for 3 months. Crutches were discarded as the symptoms (pain and limping) allowed. After discharge, a home program of isometric muscle strength exercises on both sides of the hip was prescribed and patients were encouraged to keep doing the exercises for 6 months. Muscle strengthening exercises included hip flexion in the supine position, hip abduction in the lateral position, hip extension in the prone position, and knee extension in the sitting position. Patients were instructed to perform the exercises for two 15-minute sessions per day. Patients visited an outpatient clinic at 1, 2, and 3 months postoperatively and were asked to continue the program for 6 months. All patients were followed postoperatively for a minimum of two years.

Clinical evaluation was done preoperatively and

postoperatively (at 6 months, 1 and 2 years) using the Merle d' Aubigné hip score (5).

The maximum isokinetic torque in hip abductor muscles was measured with a Cybex 6000 (Lumex Inc., Ronkonkoma, NY, USA). Measurements were performed at the velocity of 30 degrees/second in the lateral position using the manual muscle test position. Data of both hips were recorded. The values of the maximal muscle torque divided by the patient's body weight (Nm/kg) and the peak torque in the operated hip muscles compared to that in the non-operated hip muscles were calculated and analyzed using a paired *t*-test. Regression analysis was performed using Spearman's correlation analysis to elucidate the correlation between abductor muscle strength and the Merle d' Aubigné hip score. Statistical analysis was performed using StatView 5.0 software (SAS Institute Inc, Cary, NC, USA), with $p<0.05$ regarded as statistically significant.

This study was conducted in accordance with the World Medical Association *Declaration of Helsinki.*

RESULTS

Complete follow-up was available for all patients for a period of 2 years to 5 years and 6 months (average: 3 years and 8 months). There was no infection and no dislocation or other complications after THA. The average preoperative Merle d' Aubigné hip score was 9.9 ± 1.5 and the average scores at 6 months, 1 and 2 years after operation were 14.5 ± 1.3 ($p = 0.0002$), 15.0 ± 1.0 ($p<0.0001$), and 15.0 ± 0.9 ($p = 0.0005$), respectively (Fig. 1-A). Statistically significant improvement was observed both in the pain score and in the walking score, though not in the range of motion (ROM) score (Figs. 1-B, and C).

There was a significant difference in the muscle strength between the non-operated side and the operated side until 6 months postoperatively, but there was no significant difference at 1 and 2 years postoperatively (Fig. 2). Statistically significant improvement of the abductor muscle strength was observed at 1 year in the operated hip (Fig. 2).

The preoperative ratio of peak abductor muscle torque in the operated hip to the non-operated hip was 68.6 ± 31.4 % and the average ratios on follow-up at 6 months, 1 year and 2 years after operation

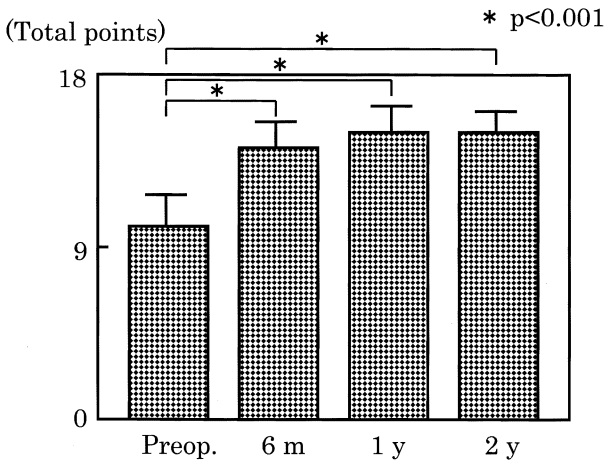

Fig. 1-A. Merle d' Aubigné hip score. Each bar represents the mean ± S.D. Eighteen points represent full marks. Abbreviations: Preop.: preoperative ; 6 m : 6 months after THA ; 1 y: one year after THA ; 2 y : 2 years after THA.

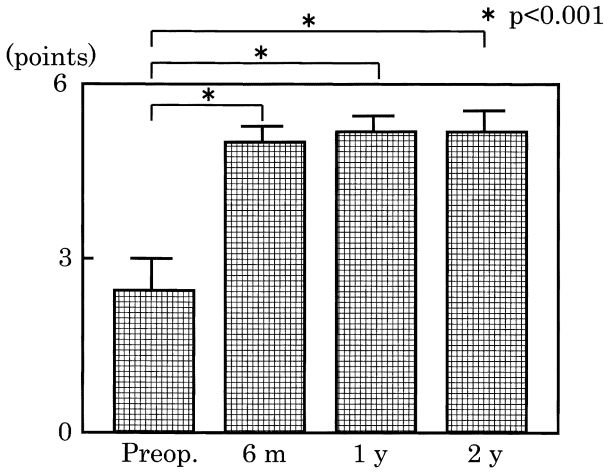

Fig. 1-B. Merle d' Aubigné hip score for pain. Each bar represents the mean ± S.D. Six points represent full marks. Abbreviations as in Fig. 1-A.

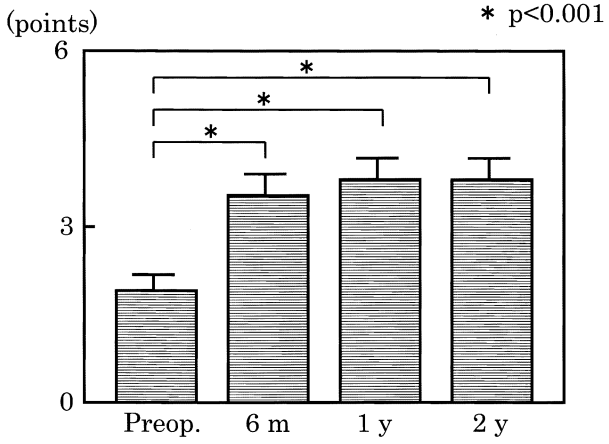

Fig. 1-C. Merle d' Aubigné hip score for walking. Each bar represents the mean ± S.D. Six points represent full marks. Abbreviations as in Fig. 1-A.

were 77.8 ± 31.4 % (p = 0.40), 91.4 ± 29.4 % (p = 0.04), and 90.4 ± 22.9 % (p = 0.03), respectively (Fig. 3).

Body weight-adjusted peak torque in the operated hip abductor muscles showed a correlation with the Merle d' Aubigné hip score at 1 year after operation (r = 0.635, p = 0.049) (Fig. 4).

DISCUSSION

In our study, significant improvement of abductor muscle strength was observed at 1 year postoperatively (Figs. 2 and 3). Muscular recovery occurred a little later than the improvement in the Merle d' Aubigné hip score, probably because immediate pain relief after THA resulted in the improvement of hip score at 6 months postoperatively. Recovery of the muscle strength corresponded well to the hip score at 1 year postoperatively (Fig. 4). Although the peak torque in the operated hip was still less than that in the non-operated hip at 2 years, the ratio of peak torque was improved at 1 year (91.5 ± 21.2 %) and significantly increased at 2 years postoperatively (93.4 ± 20.8 %) (p = 0.04). Recovery of the abductor strength in the non-operated hip occurred after THA because improvement in pain and walking ability led to improved muscle function of the both hips. Shih *et al.* (6) remarked that muscle strength of the operated hip had not reached that of the non-operated hip in the one-year follow-up period. This is probably due to increase of muscle strength in the non-operated hip as well as the operated hip owing to the home exercise program.

Patients were encouraged to exercise in the outpatient clinic at 1, 2, and 3 months postoperatively, but we could not strictly supervise the patients, and their compliance with the home exercise program could not be assessed. Sashika *et al.* (7) noted the importance of the home program for the results of THA, and also remarked that improvement in muscle strength resulted from the 6-week home program and not from natural recovery. However, their observation period was only 6 weeks and their subjects were recruited from patients whose mean period after THA was 26.4 months (range, 6 to 48 months). Our results demonstrate that muscle exercise for 6 months after THA could improve abductor muscle strength

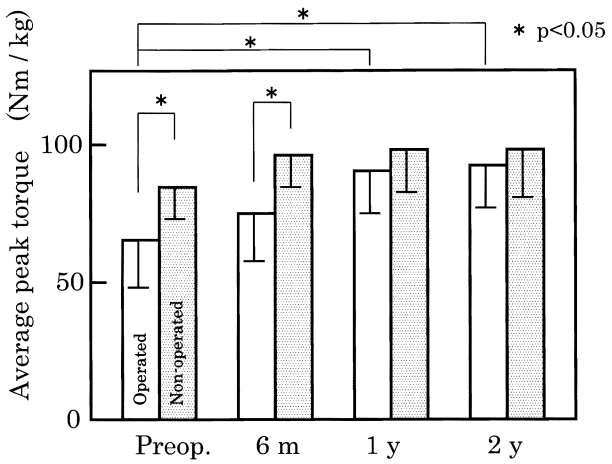

Fig. 2. Temporal changes in abductor muscle strength after THA. Each bar represents the mean ±S.D. Abbreviations: Operated : the operated hip ; Non-operated hip : the non-operated hip. Another abbreviations as in Fig. 1-A.

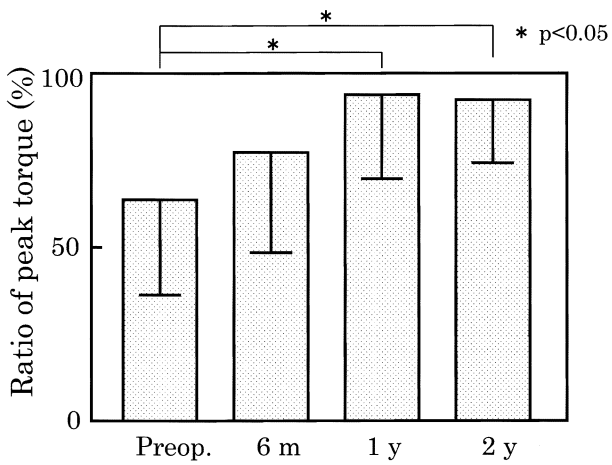

Fig. 3. Temporal changes in the ratio of abductor muscle strength. Each bar represents the mean ±S.D. Abbreviations as in Fig. 1-A.

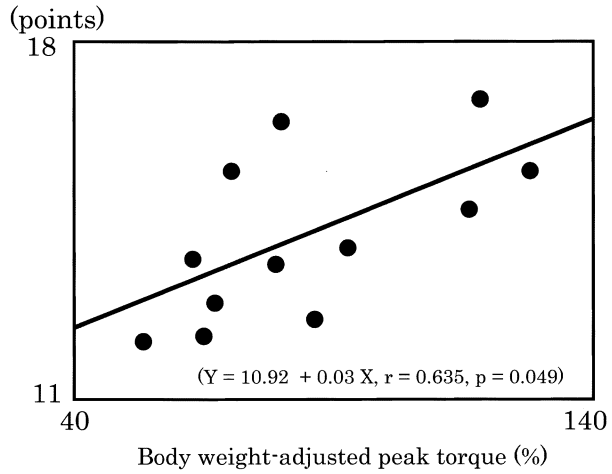

Fig. 4. Correlation of abductor muscle strength and Merle d' Aubigné hip score at 1 year postoperatively. Abbreviations as in Fig. 1-A.

and hip function, and suggest that the DLA does not have a harmful effect on hip abductor muscle strength recovery.

A weak point of this study is the lack of comparison of muscular recovery between the DLA and the PA in THA. Barber *et al.* (8) examined the differences in clinical outcome between the DLA and the PA in THA. They found no difference in abductor weakness, as shown by limping and the Trendelenburg test, when comparing the two approaches. Downing *et al.* (9) used a kinetic communicator device to study the hip abductor strength after THA using both the DLA and the PA for one year postoperatively, and did not find any significant difference between the two approaches in hip abductor strength recovery at 3 months or 12 months. We used the ratio of peak torque of both hips to evaluate the recovery of muscle strength, because normal hip muscle strength is always the ultimate goal, and we observed good recovery of the peak torque (91% at 1 year and 90% at 2 years postoperatively) in the operated hip after the DLA.

Another possible criticism of this study is the possible alteration of the hip center (deviation of the center of the femoral head compared with the non-operated hip) Changes in the location of the hip center (the center of the femoral head) may change the lengths of the abductor muscles, and thereby affect their capacity to generate force and moment about the hip. However, our patients showed almost normal or mild subluxation (group I and II of Crowe's classification) in their hips. We therefore believe that the effect of a small difference in the hip center on the results is negligible.

Many different surgical approaches to the hip have been employed for THA. Advantages of the DLA include preservation of the posterior capsule and external rotators, which may reduce the dislocation rate, and excellent exposure of the acetabulum and proximal femur (10). Disadvantages of the DLA include an increased incidence of abductor weakness, which is thought to be due to incomplete repair of the abductor muscles and injury to the inferior branches of the superior gluteal nerve that innervate the anterior abductor musculature in addition to the tensor fascia femoris muscle. Several studies (11, 12) reported that the DLA was associated with a high incidence of limping, positive Trendelenburg test, and electromyography-proven damage to the inferior branch of the superior gluteal nerve. Our patients did not show excessive abductor weakness after operation, but experienced satisfactory recovery until 2 years postoperatively. To minimize potential nerve injury, care should be taken not to extend the dissection of the gluteus medius more than 3 cm proximal to the tip of the greater trochanter (11). It is also important to be gentle during the operation so as not to cause traction injury to the inferior branches of the superior gluteal nerve. Meticulous repair is also essential to the restoration of abductor strength. The gluteus minimus muscle should be reattached to the greater trochanter tip with non-absorbable suture, and the tendinous portion of the gluteus medius should also be repaired tightly.

Although this study is limited in the number of patients, we followed consecutive patients for at least 2 years and evaluated the recovery of muscle strength using a validated measuring device, comparing the non-operated hip with the operated hip pre- and postoperatively. Our results indicate that it takes about 1 year to regain an almost normal level of abductor muscle strength after THA using the DLA and also that osteoarthritic women should continue their muscle exercise program for at least 6 months.

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