Acta Orthop. Belg., 2015, **81**, 398-405

ORIGINAL STUDY

Isokinetic performance of hip muscles after revision total hip arthroplasty via previous anterolateral approach

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We investigated the isokinetic performance of hip muscles and clinical outcomes after revision total hip arthroplasty (THA) via same anterolateral approach used in primary surgery. Thirty patients who had undergone previous THA via an anterolateral approach underwent both acetabular and femoral component revision after aseptic loosening. The Harris Hip Score (HHS) was evaluated during a minimum 2-year follow-up. The isokinetic muscle strength of the operated and nonoperated hips was assessed 1 year after surgery. The HHS improved from 49.0 to 77.4. Operated and nonoperated hips exhibited similar isokinetic performance during all measurements (flexion, extension, and abduction) ($p > 0.05$). This prospective study showed that the anterolateral approach preserves abductor strength after revision THA in aseptic cases with acceptable functional and clinical results. The main clinical relevance of this study is that the same anterolateral approach used in previous primary THA is also safe and viable for revision THA.

Keywords : anterolateral approach ; revision hip arthroplasty ; isokinetic performance.

INTRODUCTION

As our population ages, the number of primary total hip arthroplasty (THA) procedures performed continues to rise dramatically, and the burden of revision THA procedures is also expected to increase (*24,23*). Several factors influencing the outcome of revision THA have been investigated, including the surgical approach (*11,16,25*), implant design (*17,5*), fixation method (*13,26*), and combined factors (*4,10,12*). A wide variety of results with different parameters have been reported, and these results have dramatically influenced the choices of surgeons during their practice. Therefore, achieving objective results using objective parameters has a crucial influence on choosing a reliable surgical approach, implant design, and other factors impacting the outcome of revision THA.

Isokinetic muscle testing has been used to objectively measure the return of muscle strength after

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No benefits or funds were received in support of this study. The authors report no conflict of interests.

major joint arthroplasty procedures and good reliability of isokinetic testing of the hip muscles after hip and knee arthroplasty has been demonstrated (*1,18,21,22*). Isokinetic performance after primary THA without selection of the approach was evaluated by comparing patients' operated and nonoperated hips (*1*). The operated and nonoperated hips exhibited similar biomechanical performance. In another study, two different approaches to primary THA were compared with respect to the isokinetic performance of the hip abductor muscle (*3*).

In the present study, we used isokinetic muscle testing to objectively evaluate the recovery of hip muscle strength after revision THA using the anterolateral approach. The clinical and radiographic outcomes of the patients were also evaluated. To the best of our knowledge, no prospective study has compared the isokinetic muscle strength of the operated and nonoperated hips after revision THA with the same anterolateral approach used in the previous primary THA. The hypothesis of the present study was that the anterolateral approach preserves abductor strength in the first revision THA and that the same anterolateral approach used in the previous primary THA is also a feasible choice for revision THA.

MATERIALS AND METHODS

After obtaining institutional review board approval and informed consent, 30 patients planning to undergo revision THA were included in the present study. The inclusion criteria were previous primary THA with an anterolateral approach and a patient age of 60 to 85 years. The exclusion criteria were rheumatological joint disease, previous knee surgery, metabolic bone disease, previous hip surgery before primary THA, periprosthetic fracture, hip dysplasia or any surgery in non-operated hip and septic loosening. None of the patients had a history of malignancy, chronic corticosteroid use, neurological disorders, or major cardiovascular events in the previous 6 months. Isolated acetabular or femoral component revisions and revisions with trochanteric osteotomy were not included in the present study. During the revision operations, the Regenerex® RingLoc® system for the acetabulum and the Arcos® Modular Femoral Revision system for the femur (Biomet Inc., Warsaw, IN, USA) were implanted using the same modified anterolateral approach and surgical technique in all patients by a single senior surgeon. Both the acetabular and femoral components were implanted without bone cement. The present study was designed as a prospective study of 30 patients who met the inclusion and exclusion criteria mentioned above, and regular follow-up data were obtained from 24 of these patients with a minimum 2-year follow-up. These 24 patients comprised 7 men and 17 women with a mean age of 74 years (range, 63-85 years).

A low dose of low-molecular-weight heparin was administered to all patients 12 hours before surgery. A previous skin incision was performed using the anterolateral (modified Watson-Jones) approach. Both the acetabular and femoral components were extracted in all cases. The abductor arm was protected in all cases ; trochanteric osteotomy was not performed in any cases. Cementless acetabular and modular femoral stems were implanted. A suction drain was placed inside the hip ; the overlying layers were closed in the anatomical planes. Suction drains were removed and the patients were mobilized 48 hours after surgery. Perioperatively, the same analgesic agent to reduce pain and the same first-generation cephalosporin to prevent infection were administered to all patients. Low-molecular-weight heparin was administered for 6 weeks postoperatively to prevent deep vein thrombosis.

Muscle strength training commenced 3 day postoperatively for all patients. Walker use was initiated in the hospital and was discontinued an average of 6 weeks after surgery. Patients underwent regular sessions of outpatient or home-based physical therapy. Follow-up visits were performed at 6 weeks ; at 3, 6, and 12 months ; and every year thereafter. The Harris hip score (HHS) of each patient was recorded before the operation and during the follow-up visits. The HHS was used to assess the clinical outcome 1 year after THA. Radiographs of the operated hips were evaluated with respect to implant loosening. All patients underwent one isokinetic evaluation 1 year after surgery. In the previous study, isokinetic performance was evaluated 5 months after primary THA (*1*). This time period was chosen for several reasons in that study : postoperative healing was significantly complete, the risk of dislocation was significantly reduced, patients had resumed activities of daily living, and patients were able to execute the tests included in the study protocol (*1*). Because soft tissue healing, bony structure integration, and functional recovery require a longer period of time to complete after revision surgery than after the primary THA, isokinetic performance evaluation was performed 1 year after the surgery in the present study.

Isokinetic measurements were assessed with a Biodex System III Isokinetic Dynamometer, version 3.03

(Biodex Medical Inc., Shirley, NY, USA). Patients were positioned on the dynamometer in the supine position for hip flexion and extension measurements. The patients were positioned on their side during the hip abduction measurement. We observed precautionary measures during testing, such as hip flexion of ≤ 90°, no hip adduction past the neutral position, and no internal rotation past the neutral position. The physical therapist helped the patients to achieve proper positioning before each test. While matching the hip joint axis of rotation with the center of rotation on the dynamometer arm, we used the greater trochanter as the bony landmark. Reciprocal concentric isokinetic hip flexion-extension and adduction-abduction were assessed at a preset velocity of 90º/sec and 60º/sec, respectively, over a range of motion of 0º to 45º for both parameters. A fixed number of 10 flexion-extension and adduction-abduction repetitions were completed by each patient. Instructions were provided, and one trial repetition was then performed by all patients. The nonoperated control limb was evaluated first in every patient.

All data were calculated as mean and standard deviation. Statistical calculations were performed with SPSS 21.0 (SPSS Inc., Chicago, IL, USA). A P value of < 0.05 was considered statistically significant. Wilcoxon's signed-rank test was used for statistical analysis of the preoperative and postoperative HHS. Statistical differences between the isokinetic performances of the operated and nonoperated hips were evaluated by the Mann-Whitney U test.

RESULTS

Although the present study was designed to include 30 patients, 2 patients were excluded owing to infection and dislocation, respectively, during the minimum 2-year follow-up (mean, 3.2 years; range, 2-4 years). Four patients could not tolerate the isokinetic testing and were thus excluded from the study. The mean duration between primary THA and revision surgery was 9.3 years (range, 6-15 years). The mean HHS of the patients improved from a preoperative value of 49.0 ± 10.8 to 77.4 ± 10.6 at 1 year after revision surgery. During the maximum 4-year follow-up period, there were no stem failures due to aseptic loosening (Fig. 1).

The intraclass correlation coefficient was calculated for all biomechanical measures to estimate the test-retest reliability of the Biodex. Any measurement with a reliability coefficient of > 0.75 is considered to have good reliability (*19*). All of the intraclass correlation coefficients (0.89-0.96 for peak torque, 0.85-0.91 for total work, and 0.84-0.93 for average power) for the Biodex biomechanical measurements (flexion, extension, and abduction) were > 0.75 in the present study. Therefore, the Biodex was shown to be an acceptable measurement tool for evaluating the isokinetic performance of the hip muscles.

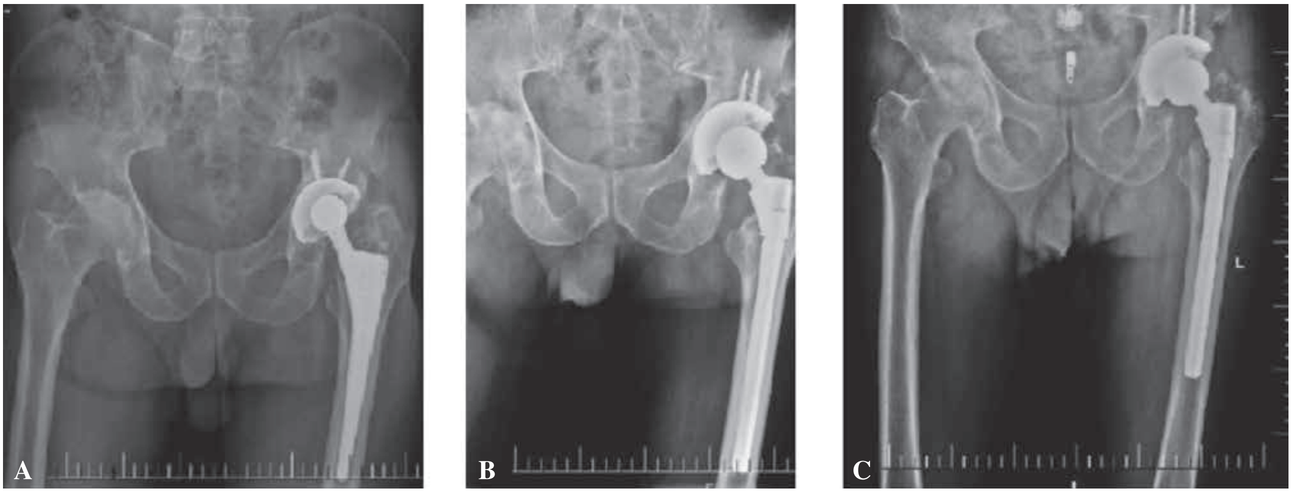

Fig. 1. — Preoperative (A), postoperative (B), and follow-up AP (C) X-rays of the patient following revision THA via previous anterolateral approach.

Table I. — Isokinetic performance of the operated and non-operated hips after revision THA

		Peak Torque	Total Work (ft-lbs)	Average Power (W)
Flexion	Operated	13.4 ± 4.7	139 ± 51	3.7 ± 2.1
	Nonoperated	15.1 ± 5.5	177 ± 64	4.5 ± 1.9
Extension	Operated	25.1 ± 8.6	207 ± 84	27 ± 13
	Nonoperated	29.3 ± 8.9	253 ± 105	32 ± 16
Abduction	Operated	18.3 ± 7.7	18.1 ± 6.8	22.4 ± 8.2
	Nonoperated	20.9 ± 7.6	20.6 ± 6.9	24.8 ± 9.3

The values are given as the mean and the standard deviation.

The isokinetic measurement values of the operated and nonoperated hips during flexion, extension, and abduction are shown in Table I. The operated hips had the highest values for peak torque per body weight and average power during extension followed by abduction and flexion, respectively. The operated hips had the highest values for total work during extension followed by flexion and abduction, respectively. The orders of isokinetic measurements during flexion, extension, and abduction were identical for the nonoperated hips.

The P values of peak torque during flexion, extension, and abduction were 0.243, 0.050, and 0.149, respectively ; those of total work during flexion, extension, and abduction were 0.127, 0.097, and 0.212, respectively ; and those of average power during flexion, extension, and abduction were 0.187, 0.186, and 0.348, respectively. With respect to the peak torque per body weight (Fig. 2), total work (Fig. 3), and average power (Fig. 4) measurements during flexion, extension, and abduction, there were no statistically significant differences between the isokinetic performances of the operated and nonoperated hips.

DISCUSSION

The main finding in this study is that the same anterolateral approach used in the previous primary THA preserved the hip muscle strength after

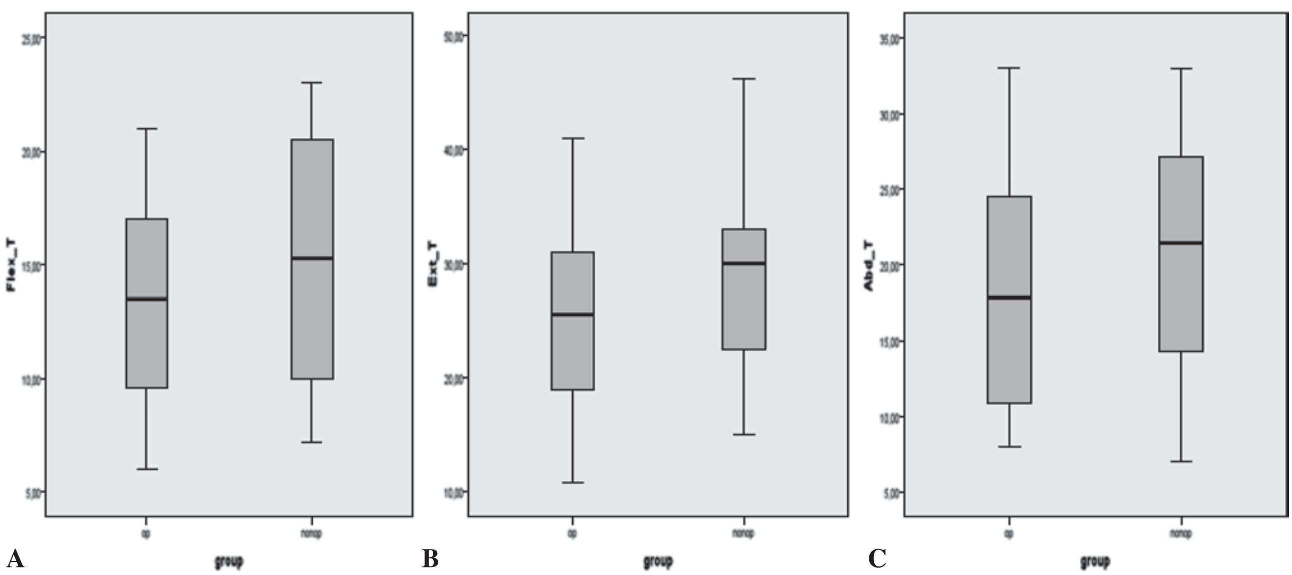

Fig. 2. — Boxplots for comparisons of the peak torque per body weight of the operated and nonoperated hips during flexion (A), extension (B), and abduction (C) 1 year after revision THA.

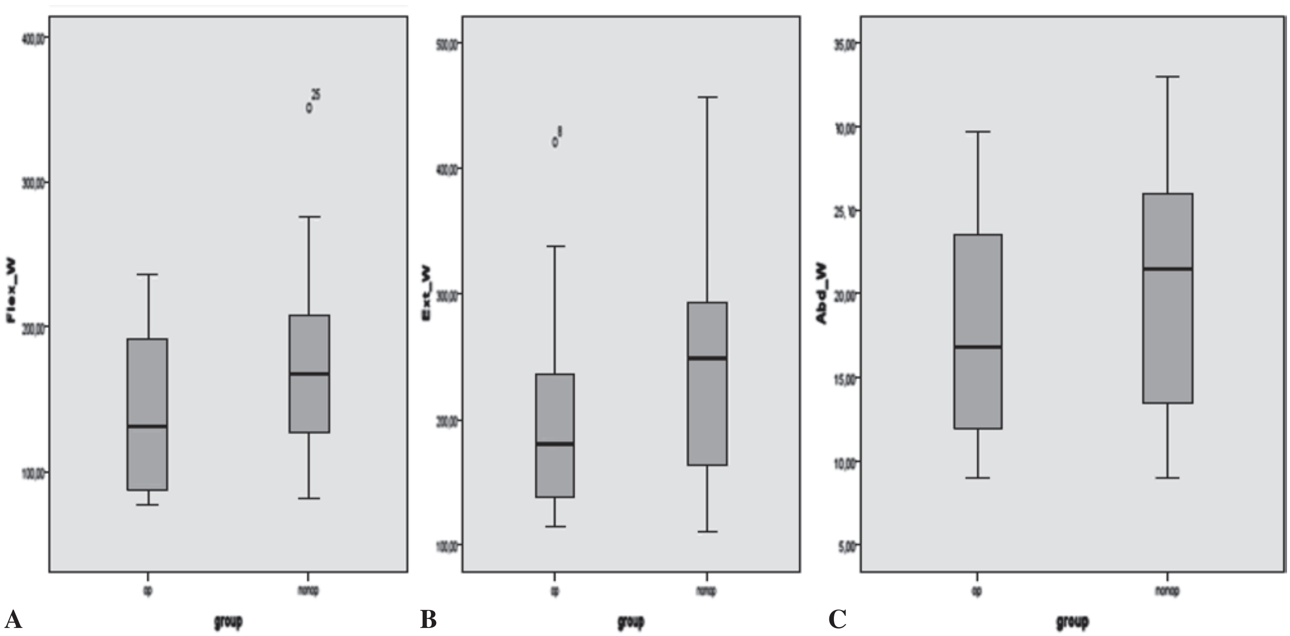

Fig. 3. — Boxplots for comparisons of the total work of the operated and nonoperated hips during flexion (A), extension (B), and abduction (C) 1 year after revision THA.

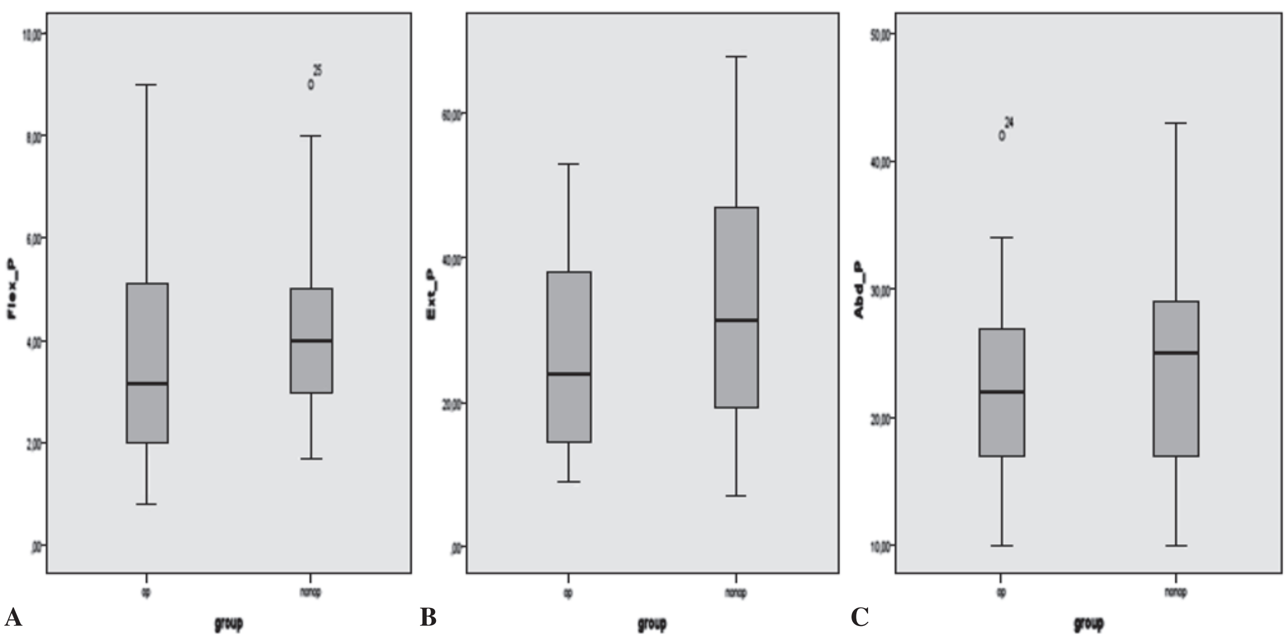

Fig. 4. — Boxplots for comparisons of the average power of the operated and nonoperated hips during flexion (A), extension (B), and abduction (C) 1 year after revision THA.

revision THA in aseptic cases with acceptable functional and clinical results. As the incidence of revision THA has increased with the more frequent performance of primary THA in orthopedic practice, the influence of the operative technique on the postoperative results of revision THA has become a matter of debate (*4,5,10-14,16,17,25,26*). Factors influencing the outcome of revision THA, such as the surgical approach, implant design, and fixation method, have been previously studied. In the present study, the outcome of the anterolateral approach after the first revision THA was objectively evaluated by isokinetic performance testing of the hip muscles.

There are some limitations to this study. First, the preoperative strength of the hip muscles was not evaluated. Instead of comparison between the preoperative and postoperative strength of the hip muscles, the muscle strength of the operated and nonoperated hips was compared. Second, isokinetic performance of patients was tested 1 year after surgery ; however, additional testing at 6 months and 2 years after surgery may achieve a more accurate evaluation of hip muscle recovery and strength after revision THA. Third, we used only the HHS for the clinical evaluation ; different clinical evaluation methods could also be used to examine correlations between isokinetic performance and clinical outcomes after revision THA. Finally, isokinetic performance tests started with the nonoperated hips. Because of the learning curve, it might be advantageous to start with the nonoperated hip during isokinetic testing.

The current body of orthopedic literature on revision THA focuses mainly on implant survival and revision techniques (*24*). In these studies, the HHS was mainly used for evaluation of clinical outcomes, and significant improvements in the HHS were reported (*12,16,17*). The HHS also improved after revision THA in the present study, supporting previous studies. Another main concern about primary THA and revision THA is the choice and influence of the surgical approach on the postoperative results. The anterolateral (modified Watson-Jones) and posterior approaches are two of the most commonly used approaches in THA (*15*). No differences in hip scores, revision rates, or gait mechanics have been shown between these two approaches (*15,20*). Muscle weakness is the most frequent functional problem after THA (*2*). The influence of different approaches on postoperative muscle weakness and functional recovery were investigated in several studies (*6-8*). The anterior and anterolateral approaches showed no differences in the recovery rate (*8*). In a study examining the patient recovery pattern during the first year after THA, patients experienced early postoperative losses in strength and functional capacity (*6*). Although the patients' functional level and clinical status were better than the preoperative levels 1 year postoperatively, their functional status still remained lower than that of healthy adults (*6*). The effects of the surgical approach on the outcome of revision THA were also investigated in recent years (*4,10-12,16,25*). The direct anterior approach reportedly had successful clinical outcomes with less scarring than the previous posterior and anterolateral approaches (*11*). Although the transfemoral approach was suggested to have good clinical results (*12*), the endofemoral approach has shown better short-term outcomes and functional results (*4*). The posterior endofemoral approach with strict soft tissue repair is reportedly associated with low dislocation rates (*10,25*). In a comparative study of the posterolateral and anterolateral endofemoral approaches for isolated acetabular revisions, the anterolateral approach was suggested to be a more viable option (*16*).

The anterolateral approach is one of the main approaches used in revision THA. Its advantages include avoidance of direct exposure of the sciatic nerve and facilitation of accurate positioning of the acetabular component (*14*). The main disadvantage of this approach is the slow recovery of abductor muscle strength (*14*), because the abductor muscles of the hips are crucial for gait and stability of the hip joint (*9*). The hip abductors exhibited the greatest post-THA strength loss among all of the hip musculature (*6*). Delayed recovery of the abductor muscles after primary THA was reportedly the main functional problem with the direct lateral approach compared with the posterior approach in the early postoperative period ; however, that delayed recovery was not observed for more than a 2-year follow-up (*7*). The wide variety of parameters used in the aforementioned studies has raised questions about the need for objective measures while evaluating various surgical approaches and their postoperative outcomes.

Isokinetic muscle testing has been used to objectively evaluate muscle recovery and function after major joint arthroplasty procedures (*1,3,18,21,22*). A previous study showed that after primary THA, the operated hip exhibited isokinetic performance similar to that of the nonoperated hip, but significantly lower isokinetic performance than a population of healthy subjects (*1*). While the study took into consideration that the hip muscles sustain further damage during revision THA, the muscle strength of healthy individuals was not considered as an objective measure for comparison with operated patients in the present study because even in the primary THA, the functional level of operated patients reportedly remains lower than that of healthy adults (*1,6*). Thus, the nonoperated hips of the patients were deemed the control hips by which to evaluate the postoperative isokinetic performance of the hip muscles after revision THA via the modified anterolateral approach. After the first revision surgery via the previous modified anterolateral approach, we found that the HHS had significantly improved and that the operated and nonoperated hips showed no significant differences in the isokinetic testing results. Our results objectively resolve the concerns about abductor deficiency after revision THA via the anterolateral approach, which has been suggested to be the main disadvantage of this approach.

In summary, this prospective study showed that the same anterolateral approach used in the previous primary THA preserved the hip muscle strength after revision THA in aseptic cases with acceptable functional and clinical results. Abductor muscle strength deficiency does not need to be considered by surgeons when performing the first revision THA via the previously used anterolateral approach.

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