

THE ROLE OF PATIENT RESTRICTIONS IN REDUCING THE PREVALENCE OF EARLY DISLOCATION FOLLOWING TOTAL HIP ARTHROPLASTY

A RANDOMIZED, PROSPECTIVE STUDY

BY E. LOUIS PEAK, MD, JAVAD PARVIZI, MD, FRCS, MICHAEL CIMINIELLO, MD, JAMES J. PURTILL, MD,
PETER F. SHARKEY, MD, WILLIAM J. HOZACK, MD, AND RICHARD H. ROTHMAN, MD, PhD

*Investigation performed at the Department of Orthopaedic Surgery,
the Rothman Institute of Orthopaedics at Thomas Jefferson University Hospital, Philadelphia, Pennsylvania*

Background: It is currently unknown whether functional restrictions following total hip arthroplasty can reduce the prevalence of early postoperative dislocation. Our hypothesis was that dislocation was more likely to occur in patients who were not placed on these restrictions.

Methods: We performed a prospective, randomized study to evaluate the role of postoperative functional restrictions on the prevalence of dislocation following uncemented total hip arthroplasty through an anterolateral approach. Of the 630 eligible consecutive patients, 265 patients (303 hips) consented to be randomized into one of two groups (the "restricted" group or the "unrestricted" group). The patients in both groups were asked to limit the range of motion of the hip to $<90^\circ$ of flexion and 45° of external and internal rotation and to avoid adduction for the first six weeks after the procedure. The patients in the restricted group were instructed to comply with additional hip precautions during the first six weeks postoperatively. Specifically, these patients were managed with the placement of an abduction pillow in the operating room before bed transfer and used pillows to maintain abduction while in bed; used elevated toilet seats and elevated chairs in the hospital, in the rehabilitation facility, and at home; and were prevented from sleeping on the side, from driving, and from being a passenger in an automobile. All patients were followed for a minimum of six months postoperatively.

Results: There was one dislocation in the entire cohort (prevalence, 0.33%). This dislocation occurred in a patient in the restricted group during transfer from the operating table to a bed with an abduction pillow in place. Patients in the unrestricted group were found to return to side-sleeping sooner ($p < 0.001$), to ride in automobiles more often ($p < 0.026$), to drive automobiles more often ($p < 0.001$), to return to work sooner ($p < 0.001$), and to have a higher level of satisfaction with the pace of their recovery ($p < 0.001$) than those in the restricted group. There was an additional expenditure of approximately \$655 per patient in the restricted group.

Conclusions: Total hip arthroplasty through an anterolateral approach is likely to be associated with a low dislocation rate. Removal of several restrictions did not increase the prevalence of dislocation following primary hip arthroplasty at our institution. However, it did promote substantially lower costs and was associated with a higher level of patient satisfaction as patients achieved a faster return to daily functions in the early postoperative period.

Level of Evidence: Therapeutic Level I. See Instructions to Authors for a complete description of levels of evidence.

A multitude of factors contribute to dislocation after total hip replacement, including component malposition, surgical approach, and soft-tissue-related fac-

tors¹⁻⁷. Patient education is thought to be a key element in the prevention of this complication⁸. To enforce the importance of avoiding extremes of motion and largely to protect the soft-tissue repair, various postoperative restrictions have been proposed for patients undergoing total hip arthroplasty⁹. Although early perioperative restrictions (such as the use of an



A commentary is available with the electronic versions of this article, on our web site (www.jbjs.org) and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM).

in-hospital abduction pillow, the use of a pillow between the legs during sleep, the use of a high chair and an elevated toilet seat, the limitation of certain ranges of motion, and the avoidance of driving or being a passenger in an automobile) are frequently recommended, the value of these restrictions in preventing early dislocation has not been evaluated. A recent prospective study demonstrated that the rate of early dislocation was acceptably low in patients who did not observe postoperative restrictions following total hip arthroplasty¹⁰. That study, however, was not randomized and lacked a comparison group. The present randomized, prospective study was specifically designed to elucidate whether there was a difference in the prevalence of dislocation within six months after total hip arthroplasty among patients who did not observe a standard set of precautions.

Materials and Methods

Demographics

The study group comprised 265 patients (303 hips) who underwent uncemented primary total hip arthroplasty through an anterolateral approach between March and December 2002 at our institution (see Appendix). The patients included 139 male patients and 126 female patients with a mean age of 58.3 years (range, fourteen to eighty-eight years) ($p = 0.39$). There were no significant demographic differences between the groups. The mean body mass index was 29.3 kg/m² (range, 15.9 to 50.2 kg/m²) for the patients who were managed with full hip precautions (the "restricted" group) and 28.7 kg/m² (range, 17.6 to 45.7 kg/m²) for those who were not (the "unrestricted" group) ($p = 0.34$).

Inclusion Criteria

All patients undergoing primary total hip arthroplasty were eligible for inclusion. Institutional approval for the study was obtained, and all patients gave informed consent. The exclusion criteria included a history of surgery on the ipsilateral hip, hyperflexibility syndromes, and neuromuscular compromise (e.g., Alzheimer or Parkinson disease). Patients who did not give informed consent also were excluded. Of the 630 patients (725 hips) who were managed with primary total hip arthroplasty during the study period, 365 patients (422 hips) elected not to enroll in the study or were excluded. No patients were excluded for hyperflexibility, Alzheimer disease, or Parkinson disease. Risk-aversion to the study's protocol was the most common reason cited for nonparticipation, as some patients did not want to be assigned to the "unrestricted" group. Other patients declined to participate because of the time commitment required to take part in the study. Thus, the patients in the study group represented 42.1% of all patients (41.8% of all hips) who were managed with primary total hip arthroplasty during this time-interval.

Surgical Data

With the exception of the study variables, the preoperative, intraoperative, and postoperative management was the same for the patients in both groups. All patients underwent neuraxial

anesthesia. All surgical procedures were performed by or under the direct supervision of one of the senior authors (R.H.R., W.J.H., or P.F.S.). All procedures involved the use of a cementless femoral stem (Accolade; Stryker Orthopaedics, Mahwah, New Jersey) and acetabular cup (Trident PSL; Stryker Orthopaedics). All arthroplasties were performed through a modified Hardinge anterolateral approach with the patient in the supine position¹¹⁻¹³. The size of the components was determined on the basis of preoperative template measurements and intraoperative assessment. The most common femoral head size used was 28 mm, although the size of the femoral head varied on the basis of the size of the acetabular component, the type of liner (highly cross-linked polyethylene or ceramic), the age of the patient, and the preference of the surgeon (see Appendix). For patients who received a polyethylene liner, a 22-mm head was used when the cup size was ≤ 46 mm, a 28-mm head was used when the cup size was 48 to 56 mm, and a 32-mm head was used when the cup size was ≥ 58 mm. During the years of this study, 36-mm femoral heads were introduced. A 36-mm femoral head was used for four patients who received a cup with a diameter of 60 mm. For patients who received a ceramic liner in association with the Trident acetabular shell system, a 28-mm femoral head was used when the cup size was 46 to 48 mm, a 32-mm head was used when the cup size was 50 to 56 mm, and a 36-mm head was used when the cup size was 58 to 68 mm.

The desired position of the acetabular component was 30° to 40° of abduction and 10° to 15° of anteversion. The femoral canal was prepared with sequential broach trials in 10° to 15° of anteversion. The soft-tissue tension was optimized through a combination of neck-length and offset adjustments until an axial force with the leg in extension produced 1 to 2 mm of soft-tissue laxity for male patients and 2 to 3 mm of soft-tissue laxity for female patients. During trial reductions, stability of the hip was tested in full flexion (100° to 120°); 90° of flexion and 30° of adduction; full extension (20° to 30°); 0° of extension and 45° of internal-external rotation; and 0° of extension, 30° of adduction, and 45° of external rotation with and without knee flexion (up to 90°). Such stability testing is routine in our practice and was not modified for the present study.

Once the final femoral stem and head were impacted into place, the abductor mechanism was repaired with nonabsorbable sutures in an interrupted fashion. The fascia and the subcutaneous tissue also were repaired with absorbable sutures in a similar manner.

Study Protocol

All eligible patients were approached preoperatively, and those who were interested in participating in the study gave consent. The details of the study were discussed, and it was emphasized that all patients would be expected (1) to limit the range of motion of the hip for the first six weeks to $<90^\circ$ of flexion and 45° of external and internal rotation and (2) to avoid adduction (crossing the legs). In addition, all patients were allowed to bear weight as tolerated and were allowed to use a walking aid for as long as they thought it was needed. The purpose of

the study, as explained to patients, was to determine whether or not additional hip precautions were truly necessary. Patients were informed about the process of randomization into one of two groups, with the patients being either “restricted” or “unrestricted” by the need to observe additional precautions. Randomization was performed preoperatively with use of a random-numbers table, but the designation of patients to either the restricted or the unrestricted protocol was double-blinded until the completion of wound closure in order to avoid any patient-selection bias or any alteration in surgical technique. Sealed envelopes that had been made only by the study coordinator were opened at the end of surgery, before bed transfer, to reveal a patient’s group assignment.

In addition to the restrictions placed on both groups, the patients in the restricted group were managed with the placement of an abduction pillow in the operating room before bed transfer; used pillows to maintain abduction while in bed; used elevated toilet seats and elevated chairs in the hospital, in the rehabilitation facility, and at home; and were prevented from sleeping on the side, from driving, and from being a passenger in an automobile. Patients in the unrestricted group were not required to follow any of these additional restrictions; however, they were given the freedom to choose to use this additional equipment, if they desired, for their comfort.

All patients were cared for by nurses and physical therapists who were experienced in working with patients managed with total joint replacement. All rehabilitation facilities to which patients were transferred were informed of the study protocol so that the patients in the unrestricted group would not be unduly restricted and would not be made to deviate from their study protocol. Detailed written postoperative instructions were reviewed with each patient by the study coordinator before discharge to ensure that each patient understood his or her assigned study protocol. At the time of discharge from the hospital, the patients were given a follow-up survey to be used as a self-administered diary to track progress and compliance. These completed surveys were returned to us at the time of the first postoperative visit, six weeks after surgery. A final survey was completed at the time of the second follow-up visit, approximately six months after surgery. Patients who were not able to return for follow-up or who did not complete their surveys were contacted by telephone and/or mail.

Patients were followed for a minimum of six months. In both surveys, patients were asked to record (1) the percentage of time that they followed each of four range-of-motion restrictions ($<90^\circ$ of flexion while bending over, $<90^\circ$ of flexion while sitting, avoidance of leg adduction, and $<45^\circ$ of internal and external rotation), (2) the specific additional equipment that they used (an elevated chair and toilet seat, pillows for leg abduction, a walker, crutches, or a cane), and (3) the postoperative time-point when they stopped using the additional equipment (see Appendix). In addition, they were asked a series of activity-related questions regarding the percentage of time spent sleeping on the back as opposed to the side, the

level of comfort when sleeping in these positions, and the amount of time before they resumed sleeping on the side, before they resumed riding in or driving an automobile, and before they returned to work. At the time of both surveys and any subsequent follow-up contacts, patients were specifically asked to confirm whether or not the hip had dislocated. At the time of the six-week survey, patients were also asked the number of times that they had driven or had been a passenger in an automobile. At the time of the six-month survey, all patients were asked the percentage of their usual daily activities that they could now perform, patients in the restricted group were asked why they were noncompliant (if applicable), and patients in the unrestricted group and patients who had had a previous contralateral hip replacement were asked to rate the ease of their recovery given their assigned study protocol. The accuracy of the patient-reported information was further confirmed by discussions with family members and health-care personnel. Finally, a standardized questionnaire designed to evaluate patient satisfaction was completed by the patients preoperatively, at six weeks, and at six months (see Appendix).

Statistical Analysis

Statistical analysis was performed with use of a chi-square test with a continuity correction for discrete variables. A one-tailed Student t test was used for continuous variables, and the level of significance (α) was set at $p < 0.05$. Before the beginning of the study, a power analysis was performed (with the value of α set at 0.05, with the value of β set at 0.80, and with use of the historic dislocation rate at our institution of approximately 1.0%) to detect a threefold difference in the dislocation rates. This analysis indicated that a minimum of 260 hips (a minimum of 130 hips in each group) would be needed to avoid a type-II error^{14,15}. A sufficient number of subjects were thus recruited to meet these requirements, and additional subjects were recruited to allow for possible attrition.

Results

Prevalence of Dislocation

There was one dislocation in the entire study; this dislocation occurred in a patient in the restricted group. Thus, the dislocation rate was 0.33% (one of 303) overall and 0.66% (one of 152) for the restricted group. The dislocation occurred during transfer of the patient from the operating table to a bed with an abduction pillow in place. Closed reduction was performed, with no subsequent episodes of instability and no need for a reoperation.

Limp

There was no difference between the two groups with regard to the prevalence of limp. At six months, the prevalence of limp (of any degree) was 12.5% in the restricted group and 13.2% in the unrestricted group ($p = 0.80$).

Patient Compliance

The level of self-reported patient compliance with range-of-motion restrictions during the first six weeks after surgery was

TABLE I Rates of Compliance with Range-of-Motion Restrictions, Equipment Usage, and Automobile Usage Within the First Six Weeks

| Study Parameter | Restricted Group (N = 152) | Unrestricted Group (N = 151) | P Value |
|---|-------------------------------|---------------------------------|---------|
| Range-of-motion restrictions* | 95.7 (25/100) | 90.0 (0/100) | 0.001 |
| Postoperative abduction pillow† | 100.0 (152/152) | 4.6 (7/151) | <0.001 |
| Elevated hip chair† | 55.9 (85/152) | 22.5 (34/151) | <0.001 |
| Elevated toilet seat† | 77.6 (118/152) | 54.3 (82/151) | <0.001 |
| Abduction pillows when supine in bed† | 57.2 (87/152) | 26.5 (40/151) | <0.001 |
| Pillows between legs for side-sleeping† | 51.3 (78/152) | 49.7 (75/151) | 0.864 |
| Regular automobile passenger† | 33.6 (51/152) | 72.2 (109/151) | <0.001 |
| First-time driver† | 19.9 (27/136) | 61.6 (85/138) | <0.001 |

*The values are given as the mean percentage of patients who were compliant with the restrictions, with the range in parentheses. †The values are given as the percentage of patients who were compliant with the restriction, with the numbers of patients in parentheses.

high in both groups, but the rate in the restricted group was significantly higher than that in the unrestricted group (95.7% compared with 90.0%; $p = 0.001$). Interestingly, a large number of patients in both groups continued to follow the range-of-motion restrictions after the required six-week period. At a minimum of six months postoperatively, the rate of voluntary compliance with these restrictions was 53.5% in the restricted group and 32.9% for the unrestricted group ($p < 0.001$).

Although not required to do so, some patients in the unrestricted group elected to use some of the equipment on occasion. The difference between the two groups with regard to the use of equipment was significant for all categories except the use of pillows for side-sleeping (Table I). The voluntary use of pillows for side-sleeping was less frequent in the unrestricted group than in the restricted group at all time-periods, but this difference was significant only during rehabilitation stays.

Patient Satisfaction

At the time of the six-month follow-up, patients in the unrestricted group reported a much greater degree of satisfaction with regard to return to their preoperative level of daily activities; specifically, patients in the unrestricted group could perform 106.4% (range, 25% to 350%) of their preoperative daily activities, whereas those in the restricted group could perform 96.5% (range, 25% to 200%) of their preoperative daily activities ($p = 0.015$). When the patients in the unrestricted group were asked to rate their recovery relative to the protocol used for the restricted group, 89.4% believed that their recovery was easier than it would have been if restrictions had been applied. The patients in the restricted group reported a compliance rate of 95.7% for range-of-motion restrictions and a 74.3% compliance rate for all restrictions. The most commonly cited reasons for the 25.7% noncompliance rate ($p < 0.001$) in this group were that some patients were dissatisfied with the additional restrictions because of their “knowledge of

the unrestricted protocol” (6.6%, $p < 0.001$) and that some patients had “planned to recover at their own pace” anyway (18.4%, $p < 0.001$). The percentage of patients who were satisfied with the pace of their recovery was greater in the unrestricted group than in the restricted group (89.4% compared with 74.3%; $p < 0.001$).

Return to Activities of Daily Living

An earlier return to activities of daily living was noted in several key areas for the patients in the unrestricted group (Table II), which contributed to an overall sense of greater satisfaction in that group. Patients began side-sleeping at an average of 3.2 weeks after surgery in the unrestricted group, compared with 5.8 weeks in the restricted group ($p < 0.001$). Significant differences in side-sleeping were noted at all follow-up time-periods. Nineteen (14.2%) of the patients in the unrestricted group began side-sleeping on the night of surgery ($p < 0.001$). Sleeping fully supine was rated as “uncomfortable” by 68.4% of the patients in the restricted group and by 65.6% of those in the unrestricted group ($p = 0.684$).

Patients in both groups were passengers in automobiles for the first time early in the recovery period. Patients in the unrestricted group were passengers for the first time at a mean of 1.5 weeks (range, 0.3 to 20.0 weeks) and took a mean of 16.8 trips (range, one to 100 trips) during the first six weeks. Patients in the restricted group were passengers for the first time at a mean of 1.9 weeks (range, zero to 6.1 weeks) and took a mean of 6.7 trips (range, zero to fifty trips) during the first six weeks ($p = 0.026$ and $p < 0.001$, respectively).

Patients in the unrestricted group drove an automobile for the first time earlier and more often in the first six weeks than those in the restricted group did. Patients in the unrestricted group drove for the first time at a mean of 4.9 weeks and took a mean of 17.3 trips in the first six weeks, whereas those in the restricted group drove for the first time at a mean of 6.8 weeks and took a mean of 5.9 trips during the

TABLE II Data on Achievement of Functional Goals

| Functional Parameter | Restricted Group (N = 152) | Unrestricted Group (N = 151) | P Value |
|--|-------------------------------|---------------------------------|---------|
| Side-sleeping* (wk) | 5.8 (0-36) | 3.2 (0-12) | <0.001 |
| First-time passenger in automobile* (wk) | 1.9 (0-6.1) | 1.5 (0.3-20.0) | 0.026 |
| First-time driver in automobile* (wk) | 6.8 (1.0-19.9) | 4.9 (0.5-16.0) | <0.001 |
| Return to work* (wk) | 9.5 (1.0-32.0) | 6.5 (0.7-20.0) | <0.001 |
| Return to work at <6 weeks† (%) | 18.8 (16/85) | 50.0 (49/98) | <0.001 |
| Ability to perform activities of daily living at 6 months‡ (percentage of preoperative value) | 96.5 (25-200) | 106.4 (25-350) | 0.015 |

*The values are given as the mean time taken to achieve the goal, with the range in parentheses. †The values are given as the percentage of patients who had returned to work within six weeks after surgery, with the numbers of patients in parentheses. ‡The data are given as the mean percentage of the preoperative value, with the range in parentheses.

first six weeks ($p < 0.001$ for both comparisons). Finally, patients in the unrestricted group returned to work at a mean of 6.5 weeks whereas those in the restricted group returned at a mean of 9.5 weeks ($p < 0.001$). Fifty percent of the working patients in the unrestricted group returned to work less than six weeks after surgery, compared with only 18.8% of those in the restricted group ($p < 0.001$). All ninety-eight of the working patients in the unrestricted group had returned to their usual jobs after six months of follow-up, compared with only eighty-one of eighty-five patients in the restricted group ($p = 0.096$).

Duration of Hospitalization

There was no significant difference between the two groups with regard to the duration of hospitalization. The mean hospital stay was 3.5 days (range, two to five days) for patients in the restricted group and 3.5 days (range, two to eight days) for those in the unrestricted group ($p = 0.88$). However, the number of patients who required a rehabilitation stay was significantly higher in the restricted group than in the unrestricted group (125 hips compared with 100 hips; $p < 0.002$).

Costs

The lack of a need for additional equipment and devices in the unrestricted group was associated with a cost savings of approximately \$655 per patient. This included the cost for an abduction pillow (\$120), an elevated toilet seat (\$65), and an elevated chair (\$995 to purchase or \$15 per day to rent). This finding does not take into account the cost of transport required by the patients in the restricted group or the loss in wages because of the delay in returning to work for the patients in the restricted group.

Post-Study Statistical Analysis

As no patients were lost to follow-up, the additional subjects who had been recruited beyond the minimum requirement of 130 hips per group increased the power of the study to $\beta > 0.85$ for an α of 0.05¹⁴.

Discussion

To our knowledge, the present report is the first randomized, prospective study that has evaluated the effectiveness of the most commonly used restrictions designed to prevent dislocation during the first six months following total hip arthroplasty. The process of blinding both surgeons and patients with regard to the group assignments was continued until completion of wound closure in order to avoid the introduction of any bias in patient selection or surgical technique. The protocol was well defined and patients were followed in a strict manner. We believe that the study was nonselective and, although important exclusion criteria were observed, we believe that it included all eligible and consenting patients. The unknown effect of abandoning long-standing restrictions on the dislocation rate and the intensive time commitment required to complete the questionnaires and telephone conversations dissuaded some patients from taking part in the study. Patients who declined to participate may have been more risk-averse than those who participated. Nevertheless, the patients who participated had a wide spectrum of diagnoses (including obesity) and demographic characteristics. Our findings suggest that patients are much more satisfied when fewer restrictions are imposed on them following hip arthroplasty. They regain their autonomy and resume daily activities faster, enjoy better sleep, and even return to work earlier once they can drive.

A large number of patients in the present study observed the restrictions. Overall, patients in the restricted group were an average of 73.1% compliant with all aspects of their protocol. The patients in the unrestricted group were less compliant than those in the restricted group with regard to range-of-motion restrictions at six weeks. Patients in the unrestricted group also were less likely to restrict their motion voluntarily at six months. The most common reasons that patients in the restricted group were noncompliant and in violation of the protocol were that they did not obtain an elevated chair for home use and did not use pillows when supine in bed or for side-sleeping.

Another benefit of removing some of the traditional hip precautions is the associated economic savings. The estimated cost savings in this study were substantial, and the environmental burden associated with discarding equipment such as abduction pillows was reduced.

The present study had some limitations. First, it is conceivable that despite the pre-study power analysis and inclusion of a relatively large number of patients, the lack of a significant difference between the two groups with regard to the rate of dislocation was the result of a type-II statistical error. We believe that this is unlikely given the increased statistical power in the post-study statistical analysis. In addition, a recent retrospective review of postoperative complications in more than 1000 patients undergoing total hip arthroplasty at our institution revealed that the rate of early dislocation continues to be <1% despite the abandonment of most patient restrictions.


Second, all of the hip arthroplasties in the present series were performed through an anterolateral approach, which is believed to be associated with a lower rate of dislocation than the posterolateral approach^{3,16,17}. Hence, the applicability of these findings to total hip arthroplasties performed through approaches other than the anterolateral approach remains questionable. In addition, all procedures were performed by or under the direct supervision of experienced surgeons who each perform more than 500 total hip arthroplasties annually. Moreover, these hip replacements were performed with the patient in a supine position, which affords improved accuracy of acetabular component positioning and restoration of limb length¹⁸. The combination of these factors could have contributed to the already low dislocation rate in the study group.

Third, the present study evaluated patients undergoing uncomplicated primary hip arthroplasty and excluded those with predisposing factors to hip instability such as previous hip surgery and potential abductor weakness, neurological conditions, hyperflexibility, or other connective-tissue disorders. Last, and perhaps most important, all patients in the present study were clearly instructed to avoid crossing their legs, to avoid hip flexion beyond 90°, and to avoid excessive rotation that could jeopardize soft-tissue and abductor repairs for six weeks postoperatively. We believe that it is important for patients to be given detailed instructions regarding these range-of-motion precautions in order to allow better soft-tissue healing because patient education still remains critical for avoiding dislocation and other complica-

tions following joint arthroplasty.

We conclude that the imposition of restrictions other than the limitation of extremes of motion did not influence the prevalence of early dislocation in this group of patients managed with uncemented total hip arthroplasty through an anterolateral approach. On the basis of the initial findings of the present study, we now ask all patients to comply with the range-of-motion restrictions (that is, the avoidance of flexion of >90°, leg adduction, and external and internal rotation of >45°) for six weeks postoperatively, but we have discontinued the use of in-hospital abduction pillows, the avoidance of side-sleeping, the use of a pillow between the legs while supine in bed and for side-sleeping, the avoidance of driving or being a passenger in an automobile, and the use of an elevated chair or toilet seat.

Appendix

 A table presenting demographic data and details related to the surgical procedure and also the follow-up questionnaires are available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

NOTE: The authors thank the Rothman Institute research staff for their assistance with data collection and patient follow-up surveys, and Rebecca R. Peak, MStat, for her assistance with the statistical analysis.

E. Louis Peak, MD
Javad Parvizi, MD, FRCS
Michael Ciminiello, MD
James J. Purtill, MD
Peter F. Sharkey, MD
William J. Hozack, MD
Richard H. Rothman, MD, PhD
Rothman Institute, 925 Chestnut Street, 5th Floor, Philadelphia, PA 19107. E-mail address for J. Parvizi: parvj@aol.com

The authors did not receive grants or outside funding in support of their research or preparation of this manuscript. They did not receive payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, educational institution, or other charitable or nonprofit organization with which the authors are affiliated or associated.

doi:10.2106/JBJS.C.01513

References

1. Demos HA, Rorabeck CH, Bourne RB, MacDonald SJ, McCalden RW. Instability in primary total hip arthroplasty with the direct lateral approach. *Clin Orthop*. 2001;393:168-80.
2. Ali Khan MA, Brakenbury PH, Reynolds IS. Dislocation following total hip replacement. *J Bone Joint Surg Br*. 1981;63:214-8.
3. Masonis JL, Bourne RB. Surgical approach, abductor function, and total hip arthroplasty dislocation. *Clin Orthop*. 2002;405:46-53.
4. Mulliken BD, Rorabeck CH, Bourne RB, Nayak N. A modified direct lateral approach in total hip arthroplasty: a comprehensive review. *J Arthroplasty*. 1998; 13:737-47.
5. Paterno SA, Lachiewicz PF, Kelley SS. The influence of patient-related factors and the position of the acetabular component on the rate of dislocation after total hip replacement. *J Bone Joint Surg Am*. 1997;79:1202-10.
6. Woo RY, Morrey BF. Dislocations after total hip arthroplasty. *J Bone Joint Surg Am*. 1982;64:1295-306.
7. Joshi A, Lee CM, Markovic L, Vlatis G, Murphy JC. Prognosis of dislocation af-

ter total hip arthroplasty. *J Arthroplasty*. 1998;13:17-21.

- 8.** Morrey BF. Difficult complications after hip joint replacement. Dislocation. *Clin Orthop*. 1997;344:179-87.
- 9.** Charnley J. Total hip replacement by low-friction arthroplasty. *Clin Orthop*. 1970;72:7-21.
- 10.** Talbot NJ, Brown JH, Treble NJ. Early dislocation after total hip arthroplasty: are postoperative restrictions necessary? *J Arthroplasty*. 2002;17:1006-8.
- 11.** Glassman AH, Engh CA, Bobyn JD. A technique of extensile exposure for total hip arthroplasty. *J Arthroplasty*. 1987;2:11-21.
- 12.** Hardinge K. The direct lateral approach to the hip. *J Bone Joint Surg Br*. 1982;64:17-9.
- 13.** Stephenson PK, Freeman MA. Exposure of the hip using a modified antero-lateral approach. *J Arthroplasty*. 1991;6:137-45.

14. Fleiss JL. *Statistical methods for rates and proportions*. 2nd ed. New York: Wiley; 1981. p 42-6.

- 15.** Billote DB, Glisson SN, Green D, Wixson RL. A prospective, randomized study of preoperative autologous donation for hip replacement surgery. *J Bone Joint Surg Am*. 2002;84:1299-304.
- 16.** Mallory TH, Lombardi AV Jr, Fada RA, Herrington SM, Eberle RW. Dislocation after total hip arthroplasty using the anterolateral abductor split approach. *Clin Orthop*. 1999;358:166-72.
- 17.** Ritter MA, Harty LD, Keating ME, Faris PM, Meding JB. A clinical comparison of the anterolateral and posterolateral approaches to the hip. *Clin Orthop*. 2001;385:95-9.
- 18.** Austin MS, Hozack WJ, Sharkey PF, Rothman RH. Stability and leg length equality in total hip arthroplasty. *J Arthroplasty*. 2003;18(3 Suppl 1): 88-90.