Evaluation of the Learning Curve When Transitioning From Posterolateral to Direct Anterior Hip Arthroplasty: A Consecutive Series of 1000 Cases

Andrea H. Stone, MSN, CRNP [a], Udai S. Sibia, MD, MBA [b], Ryan Atkinson, BS [c], Timothy R. Turner, PhD [c], Paul J. King, MD [d, *]

[a] Research Fellow, Department of Surgical Research, Anne Arundel Medical Center, Annapolis, Maryland
[b] General Surgery Resident, Anne Arundel Medical Center, Annapolis, Maryland
[c] Department of Surgical Research, Anne Arundel Medical Center, Annapolis, Maryland
[d] Director, Center for Joint Replacement, Anne Arundel Medical Center, Annapolis, Maryland

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ABSTRACT

Background: The direct anterior approach (DAA) for primary hip replacement has been gaining more attention and widespread use in recent years. There are a number of published studies evaluating the learning curve when a surgeon changes technique; these studies typically look at complications during the initial cases. This study examines procedure and total operating room (OR) time along with all complications for a surgeon transitioning from the posterolateral approach (PA) to DAA.
Methods: A retrospective review of a single surgeon series of 1000 initial DAA procedures. Total OR time, procedure time, and complications were collected and analyzed. One-way analysis of variance and post hoc least significant difference tests were used for statistical analysis.
Results: There was an initial increase in both procedure and OR times compared with the mature PA, by 34% and 30%, respectively. The procedure time became statistically equivalent to the mature PA time after the 400th DAA case, and significantly shorter after the 850th case. The total OR time became statistically equivalent after the 900th DAA case. There were 18 early (<90 days) and 18 late reoperations performed in this series with a nonsignificant trend toward femoral complications occurring early in the series. Minimum follow-up time was 2 years.
Conclusion: There was an initial increase in both total OR time and procedure time when an experienced surgeon introduced the DAA. By the end of the series, procedure time was significantly shorter and total OR time was equivalent. Complications overall were low and femoral complications decreased with time.

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Total hip arthroplasty (THA) is one of the most common elective surgical procedures performed in the United States. Approximately, 572,000 hip arthroplasties will be performed annually in the United States by the year 2030, an increase of 174% from 2005 [1]. There are 3 main approaches for performing hip arthroplasty: posterolateral, direct lateral, and direct anterior approaches [2]. According to

Chechik et al [3], the direct anterior approach (DAA) currently accounts for about 10% of all THAs, but this approach has been gaining more attention recently.

DAA hip arthroplasty is a true internervous and intermuscular technique, leaving all muscular attachments intact. It has been associated with increased early recovery, better functional outcomes, decreased risk of dislocation, and decreased postoperative pain [4–6]. Proponents of the DAA also contend that acetabular component positioning is more consistent because of the use of fluoroscopy intraoperatively [7,8]. Opponents of the approach point to the learning curve associated with changing techniques and an increased complication rate, especially in the early cases [9], and several published meta-analyses have failed to favor the DAA over either the posterolateral (PA) or direct lateral approaches [10–12].

The learning curve is defined as the number of cases a surgeon requires of a new procedure before outcomes approach a steady state compared with their standard procedure. The learning curve associated with DAA hip arthroplasty has been previously described as 50-100 cases [13]. There are no published studies looking at a consecutive series of greater than 500 DAA THA to establish a potentially longer learning curve. In the present study, we will attempt to establish a learning curve by looking at 1000 consecutive DAA hip arthroplasties with an emphasis on total operating room (OR) time, procedure time, and complication rate.

Materials and Methods

Study Design

Institutional review board's approval was obtained. All data were collected retrospectively and deidentified. This study was a longitudinal analysis in which the primary outcome of interest was to determine the impact of cumulative volume of consecutive cases on OR time, procedure time, and complication rate.

Population and Data

We retrospectively reviewed a single surgeon series of the initial consecutive 1000 DAA primary unilateral THA procedures from March 2010 through June 2015. Operating room times and procedure times were collected using an administrative database. All data were deidentified for this analysis. Operating room time was defined as the interval between a patient entering the OR and leaving the OR. Procedure time was defined as the interval between first incision to wound closure completed. Procedures were ordered from the earliest (first procedure date in March 2010) to the latest (last procedure date in June 2015). Mean OR times and mean procedure times were calculated in consecutive intervals of 50 procedures. DAA times were compared with historic mean PA times. For the first 100 DAA cases, there were strict patient selection criteria in place based on body habitus and case complexity. After 100 cases, the DAA was used for all routine primary THA. Complications requiring reoperation were also collected from the facility electronic health record and categorized by reason for revision, what interval they occurred in and the time to revision.

Performing Surgeon

All procedures were performed by a fellowship-trained joint reconstruction surgeon whose practice focused on total hip and knee replacements. At the start of this review (January 2010), the performing surgeon had performed approximately 1500 THAs via the PA approach and also performed >200 THAs per year. Direct anterior hip replacements were first introduced in this institution at the start of this review (March 2010). Before its introduction, the performing surgeon had no experience with the DAA. He received didactic training, surgeon mentorship, assisted another surgeon at another institution, and cadaver training in the DAA technique and began performing the DAA in select patients in 2010.

Surgical Technique

Posterolateral approach hip replacements were performed in the lateral decubitus position with division and subsequent repair of the hip external rotators and posterior capsule. Direct anterior hip replacements were performed in the supine position on a modern fracture table with fluoroscopy and subsequent repair of the anterior capsule.

Outcome and Statistical Analysis

The primary outcomes of interest were the number of cases required to achieve operational efficiency of the DAA compared with the PA (defined by total OR time) and the time to procedural efficiency (defined by procedure time) for the DAA compared with the PA. To ascertain these effects, we analyzed mean OR time and mean procedure time for a longitudinal series of DAA cases in intervals of 50 cases. The mature mean PA times were calculated using the last 50 PA cases before initiating the DAA. Analysis of variance with post hoc analyses (where appropriate) was used to examine significant differences in OR times and procedure times between the cumulative DAA case intervals. Complications requiring reoperation were also cataloged and evaluated using the independent samples medians test. All analyses were performed using IBM SPSS Statistics, version 23 (Armonk, NY). A P value $\leq .05$ was treated as statistically significant.

Results

The mature mean procedure time for the PA was 81.56 minutes (95% confidence interval [CI], 74.88-88.24 minutes). Figure 1 presents the mean procedure time and CI by case interval along with the mean PA procedure time. Transitioning from the PA to the DAA increased procedure times by 34%, from 81.56 minutes to 108.98 minutes over the first 50 DAA cases ($P < .001$). Procedure times decreased over the next 50 DAA cases to an average OR time of 88.98 minutes ($P < .001$).

Table 1 presents the post hoc analysis identifying the DAA case interval after which procedure times for the DAA became equivalent and then improved compared with the traditional PA. The mean procedure time for the PA (81.56 minutes) was significantly shorter through the 151-200 case interval, then again at the 301-350 and 351-400 case intervals. After 400 DAA cases, the procedure time was equivalent to the PA time, and then significantly shorter in the 601-650 case interval and again after 850 cases. By the last interval studied, the DAA time (71.57 minutes) was 14% shorter than the historic PA time.

The mature mean OR time for the PA was 117.78 minutes (95% CI, 110.47-125.09 minutes). Figure 2 presents the mean OR time and CI by case interval along with the mean PA procedure time. Transitioning from the PA to the DAA increased OR times by 30%, from 117.78 minutes to 152.94 minutes over the first 50 DAA cases
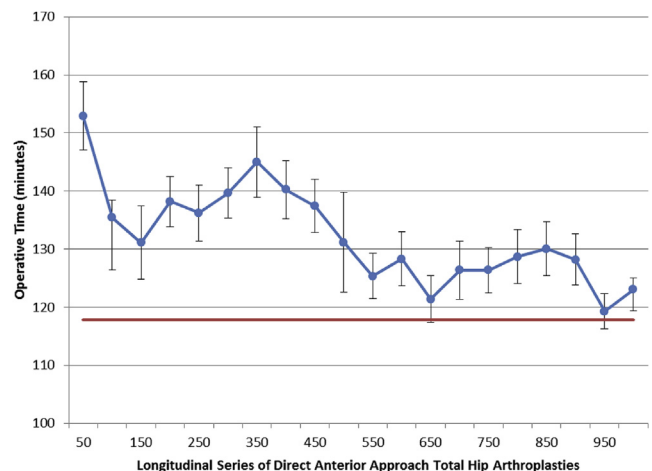

Fig. 1. Operating room time by cumulative case volume. Circles represent the means with 95% confidence intervals. Red line is the reference for the posterolateral approach operating room time (mean, 117.78 minutes).