The Rottinger approach for total hip arthroplasty: technique and review of the literature

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Abstract The surgical approach utilized in total hip arthroplasty has been identified as a factor that may affect surgical outcomes. There have been many different approaches and modifications used since the procedure was popularized by Sir John Charnley. The popular approaches today can be grouped by their relationship to the trochanter (anterior or posterior), patient position, leg position for dislocation/femoral preparation, and treatment of the abductors and short external rotators. The Rottinger approach is an anterior approach which utilizes the muscle interval between the tensor fascia lata and abductor musculature. The abductor attachments are preserved and the femur is prepared in extension, adduction, and external rotation. This approach has been shown in literature to be safe with some studies showing improved outcomes both in terms of reduced complications and better function than other standard approaches.

Keywords Total hip arthroplasty · Hip approaches · Anterior approach · Anterolateral approach · Minimally invasive hip replacement · Muscle sparing · Tissue sparing · Rottinger approach

Introduction

The chosen surgical approach has been identified as a factor that may affect the complication rate and speed of recovery

after surgery [1•]. This has led surgeons to continue to develop and refine surgical techniques and approaches.

In the 1980's, most surgeons performing hip replacement, had abandoned the trans-trochanteric approach and approached the hip joint either anterior or posterior to the trochanter. Generally, the posterior approach spared the abductor, but with the potential for a higher dislocation rate [2]. The anterior approach had the potential advantage of a lower dislocation rate, but involved releasing the anterior fibers of the abductor muscle (medius and minimus) [3–5]. In order to minimize the potential downside of each approach, the techniques have been modified to reduce instability with the posterior approach and reduce muscle trauma with anterior approaches to the hip. This has resulted in a proliferation names and terms.

Approaches posterior the trochanter are commonly referred to as the Southern, Moore, Gibson, Kocher-Langenbeck, maximum splitting, and posterolateral approaches [6–8]. Approaches anterior to the trochanter include: Smith-Peterson, Heuter, direct anterior, Watson Jones, lateral, anterolateral, abductor split, trans-gluteal, Bauer, trans-lateral, and Hardinge [9–11]. Each of these terms have been further described by one or more of the following: modified, mini, minimally invasive and muscle sparing [12–15].

Historically, approaches to the hip joint were classified by muscle intervals or anatomic structures. Approaches anterior to the trochanter have been subdivided by the tensor fascia lata muscle. The two most popular approaches were the Smith-Peterson (interval between the Sartorius and tensor fascia muscle) and Watson Jones (interval between abductors and tensor fascia lata) [16, 17].

In 2005, a modification of the Heuter anterior approach was described and subsequently popularized by Matta [10]. This is commonly referred to as the direct anterior approach and is considered muscle sparing by preserving the abductor attachment to the trochanter and using the

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sartorius/tensor fascia lata interval. Most surgeons that utilize this approach use an orthopedic traction table in order to extend and externally rotate the hip for mobilization of the proximal femur. The main bony landmark used for orientation is the anterior superior iliac spine. In 2004, Rottinger published a description of another anterior muscle sparing approach to the hip [18•]. It utilizes the same muscle interval as the classic Watson Jones approach. However, it is similar in many respects to the direct anterior approach. The Rottinger approach utilizes a split table to mobilize the femur in extension, and uses the anterior superior iliac spine as a main bony landmark for orientation. Both approaches are anterior to the trochanter, however pass in different muscle intervals in relation to the tensor fascia lata.

Both approaches share the advantages of being muscle sparing by not violating the abductor muscles. However, the Rottinger approach has the advantage of utilizing an inexpensive attachment to a standard table, with the extremity prepped free allowing range of motion and stability assessment. Additionally, because the patient is positioned lateral with this technique, dissection is extensile in every direction, including posterior. The femoral nerve is not at risk and there are no femoral component design limitations.

Given the multiple modifications to the classic approaches, and newly developed approaches, new surgical approach groupings should be considered. For simplicity sake, a surgical approach should be defined first by its relationship to the greater trochanter (posterior, anterior, and trans-trochanteric). Other considerations in grouping approaches should be leg position for mobilization of the femur (i.e. flexion vs. extension), muscle interval, and muscle detachment. When differentiating between approaches it should be recognized that muscle detachment plays a more important role than the muscle interval used for dissection. For example, the anterior approach described by Rottinger is very similar to the Matta direct anterior approach even though they utilize slightly different muscle intervals.

Description of the Anterior Rottinger approach

The patient is placed in the lateral position. A modified peg board is secured to the table and the patient is secured on the bed in a stable position. The peg board converts the lower ½ of the OR table into a split table, such that for the operative leg to be extended, adducted and externally rotated for femoral preparation (see Figs. 1, 2 and 3). Mobilization of the femur is the most challenging aspect of any anterior approach to the hip. The entire leg is prepped and draped into the operative field which allows for full range of motion and demonstration of hip stability once trials and implants have been implanted.

Fig. 1 A split let peg board is used to allow for the operative extremity to be placed in extension, adduction, and external rotation for femoral preparation

An anterior curvilinear incision is made in skin and a longitudinal incision is made in fascia. The incision is made beginning between the point half way between the anterior superior iliac spine and the superior/anterior tip of the greater trochanter. We have modified the incision to also extend distally in line with the anterior border of the greater trochanter (Fig. 4).

Dissection is carried down to the deep fascia. The fascia is divided anterior to the greater trochanter. The muscular plane between the gluteus medius laterally and tensor fascia

Fig. 2 A picture of the split leg peg board attachment to the OR bed. By dropping the lower part of the bed (bed attached to the blue foam), the operative leg is allowed to be adducted, extended, and externally rotated for femoral preparation

Fig. 3 Patient positioned on the OR bed. Notice the distal part of the OR bed has been dropped and the patient's legs are both resting on the single leg portion of the peg board. By dropping the bed there is now room for the operative extremity to be placed in the needed position for femoral preparation. The leg is placed in a sterile bag during the operation when it is placed in the extended, adducted, and externally rotated position

lata medially is developed bluntly and carried down to the femoral neck. Curved retractors are placed over the superior and inferior femoral neck (Figs. 5 and 6).

The rectus femoris is dissected from the capsule with an elevator and the medial cobra retractor placed under the rectus muscle in order to provide a clean view of the capsule (Fig. 7). A capsulotomy is performed parallel to the superior border of the femoral neck then extending distally along to the neck/greater trochanteric junction.

While the hip can be dislocated with extension and external rotation, it is often safer to osteotomize the neck and remove the femoral head when the acetabulum is fully exposed. It is best to reference off the saddle of the femoral

Fig. 4 The incision will be made connecting the three black dots marked. The main bony landmarks are the ASIS and the superior/anterior corner of the greater trochanter. For orientation for all pictures: This is a left hip with the picture being taken from anterior. Left is proximal and right is distal. All pictures that follow are taken of the same hip in the same orientation

Fig. 5 After the deep fascia is split the interval between the abductors and tensor fascia lata is developed. Blood vessels are reliably found marking the distal aspect of this interval (isolated by right angle clamp) and are either tied or cauterized

neck, but for surgeons more comfortable with lesser trochanteric reference, this can be obtained with a slight figure four position of the leg (Fig. 8).

Once the femur is mobilized, a final cut is made on the femoral neck. After the final femoral neck cut is made the obturator externus tendon is detached from the femur. This allows for improved femoral exposure (Fig. 9).

With the neck and head removed, the leg is brought back into a neutral position and the acetabulum is exposed with placement of posterior and anterior acetabular retractors. The femoral head can be removed at this time. A Steinman pin is placed at the 12 o'clock position inside the capsule and outside the labrum to improve visualization (Figs. 10 and 11). The acetabulum is then reamed and acetabular components placed. The femur is then exposed again with extension, adduction, and external rotation. A specialized modified cobra retractor is placed over the greater trochanter to retract the abductor musculature. A 2 pronged retractor is placed over the calcar medially to expose the cut surface of the proximal femoral neck (Fig. 9).

Fig. 6 The muscle interval has been divided and a curved retractor (top) placed over the femoral neck exposing the rectus femoris covering the joint capsule

Fig. 7 Another curved retractor and Bennet retractor have been placed along the inferior femoral neck and the rectus has been cleared showing a clean view of the anterior hip capsule

Femoral reaming and broaching is performed. This approach does allow for cemented fixation and straight reamers to be used (Fig. 12). Once the appropriate sized broach is selected, the desired neck and head trials are placed. The hip is reduced and with the leg free, and stability through a full range of motion can be checked.

After final component implantation the anterior capsule is re-approximated with a simple single stitch. The fascia is then repaired to close communication with the skin and subcutaneous tissue (Figs. 13 and 14).

Discussion

Hip approaches for total hip arthroplasty have been modified throughout the years in attempts to improve patient outcomes. By limiting damage to key soft tissue structures some surgeons feel that patients experience a quicker recovery and are at less risk for dislocation. These key structures have been identified as the abductor muscles (gluteus medius and minimus), and the posterior supporting structures (posterior capsule and short external rotators).

Fig. 8 The leg is placed in a Fig. 4 position in order to dissect along the femoral neck to expose the lesser trochanter

Fig. 9 The view of the proximal femur after the femoral neck cut has been made. The leg has been dropped off the bed posteriorly in the sterile bag in the full extended, adducted, and externally rotated position

The senior author's (SK) experience with the approach described by Rottinger has been very positive. It is currently his preferred approach for primary and revision hip arthroplasty procedures. From 2005–2009 the senior author performed 721 primary total hip arthroplasty procedures with the approach. There have been 9 (1.2%) reoperations. Of these 9 reoperations there were 4 femoral fractures, 3 loose femoral stems, and 2 reoperations for heterotopic ossification. The femoral fractures and loose femoral stems were felt to be related to implant choice. There have been no dislocations.

A randomized control trial published in 2011 by Muller et al. [19••] examined the abductor muscle damage with the minimally invasive anterolateral approach described by Rottinger (ALMI, $n=21$) and modified direct lateral approach (mDL, $n=16$). Using MRI to evaluate muscle damage, they found more atrophy and lateral gluteus medius tendon defects in the mDL group. The clinical outcome was also poorer in the mDL group with significantly more Trendelenburg signs. The mDL group also had lower Harris hip scores, lower satisfaction scores, and

Fig. 10 View of the acetabulum. Curved retractors have been placed over the anterior and posterior walls and a blunt cobra retractor has been placed in the acetabular teardrop for orientation. The femur is being retracted in the posterior direction (top of picture)

Fig. 11 The position of the leg during acetabular preparation. A large roll is placed in the groin to abduct the extremity and the leg is allowed to fall into external rotation

higher pain scores at 3 and 12 months, but this was not statistically significant. They concluded that the Rottinger ALMI approach damages the gluteus medius muscle less than the mDL approach and results in fewer patients with a post operative limp.

Another prospective randomized trial published in 2009 by D'Arrigo et al. [20] compared the first 20 cases done by a single surgeon with different surgical approaches. Their greatest interest was to determine the complication rate as a function of surgical approach and learning curve. The three approaches examined were the modified Hardinge (anterior one third of the abductors removed, mL), anterolateral minimally invasive approach as described by Rottinger (ALMI), and direct anterior approach (dA). These were compared to the control group of 149 hips done by the direct lateral Hardinge approach (dL). The overall complication rate was 10% in the three study groups and was significantly higher than the control group ($p=0.003$). However, there were no complications in the ALMI group. They also reported significantly better WOMAC scores in the ALMI and dA groups when compared to the approaches that remove at least part of the abductors from the greater

Fig. 12 Femoral reaming is being done with standard, straight reamers. This approach allows for safe and adequate femoral exposure. The surgeon is not limited to special reamers and broaches

Fig. 13 Closure of the hip capsule

trochanter (mL and dL). This improvement in early functional outcomes may be explained by the theory described by Zati et al. [21] and He et al. [22] This theory argues that the muscle afferent is more important than the hip capsule receptors. Therefore, approaches to the hip which split muscle or involve tenotomies will have a greater affect on the sensomotor capacity of the joint than those that do not. This may lengthen the rehabilitation period and reduce functional outcome scores.

Another prospective randomized trial published in 2008 by Wohlrab et al. [23••] compared 20 total hips done with the ALMI Rottinger approach with 20 hips done using the lateral approach described by Bauer which removes the anterior one third of the abductor muscles from the greater trochanter. They reported greater improvements in Harris hip scores at 6 and 12 weeks in the ALMI group. They concluded that even though they found improved function and gait in the ALMI group, the conventional approaches are still the gold standard. More prospective, randomized trials with greater numbers of patients are needed to determine if the functional outcome differences are real.

A prospective randomized trial published in 2011 by Martin et al. [24••] compared 42 total hips done with the Rottinger ALMI approach with 41 hips done with a lateral

Fig. 14 The gluteus medius is shown above. It has been well preserved throughout the procedure

trans-gluteal approach (which removed one half of the gluteus medius and one third of the gluteus minimus from the greater trochanter). Their main criticism of the previously done randomized controlled trials that evaluated the Rottinger ALMI approach was the small sample sizes and short follow up times. Their follow up was 1 year. The only statistically significant differences found were a longer operative time and less blood loss with the ALMI approach. The two approaches were similar with regard to complication rates, morphine consumption, and length of hospitalization. There were similar Harris, Postel and Merle d'Aubigne, and Short form-36v1 scores. Gait analysis was similar and computed tomography showed no difference in implant position, heterotopic ossification, and loosening. The similar results at 1 year are not surprising given that the proposed advantages of the tissue sparing approaches are expected in the early post operative period.

White et al. [25••] compared the Rottinger approach with the mini posterolateral approach in a blinded, prospective randomized fashion. One hundred consecutive primary total hip replacements were included. The patients were evaluated using the Harris Hip Score, the Medical Outcomes Study 6 item sleep scale (MOS Sleep Scale), and the Western Ontario and McMaster Osteoarthritis Index (WOMAC) preoperatively and at ten postoperative visits in the first 2 years. There were a total of 600 comparisons made. The Rottinger approach was statistically better in 120 (20%) of the comparisons. The mini posterior approach was statistically better in only two (0.33%). There was no difference in the remaining 478 (79.7%) of the comparisons. Prior to this study, the senior author had exclusively used the posterolateral approach and has since switched to the use of the Rottinger anterior approach as a result of the study.

Another proposed advantage of the approaches that preserve the posterior capsule and short external rotators is reduced dislocation rates. There have been no dislocations reported in the studies reporting complications of the Rottinger ALMI approach. Prior to the 2004 description of the ALMI approach by Rottinger, Masonis et al. [1] reported on fourteen studies involving 13,203 primary total hips with respect to surgical approach and dislocation. The dislocation rate for the posterior approach without repair of the posterior structures was 3.95%, but improved to 2.03% with posterior repair. The dislocation rates for the other approaches were 2.18% for the anterolateral approach and 0.55% for the direct lateral approach. Both of these approaches involved removing a portion of the abductor tendon from the greater trochanter. The trans-trochanteric approach had a dislocation rate of 1.27%. The authors concluded that due to the poor quality of the studies included in the analysis that the absolute effect of surgical approach and dislocation remains unknown.

Conclusion

Due to the excellent results of total hip arthroplasty, patients have higher expectations for their post operative function. Many patients desire a quicker recovery without an increased risk of complications. Surgical approaches have been modified and developed in order to meet these expectations. By preserving the abductor and short external rotator muscle attachments to the femur, the risk of dislocation is reduced. Also, the post operative recovery may be shortened and better tolerated. The anterior approach described by Rottinger is an approach that may accomplish these goals without exposing the patient to an increased risk of complications.

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