Minimally Invasive Single-Incision Anterior Approach for Total Hip Arthroplasty – Early Results

F. Rachbauer, M. Nogler, E. Mayr, M. Krismer

Introduction

The concept of less invasiveness has become an established aim of all surgeons in the orthopedic community. Various attempts have been made to discover the most suitable technique for minimally invasive hip arthroplasty [1-3]. Even though there is no universally accepted definition of minimal invasiveness, its focus is clearly to minimize soft-tissue trauma and accelerate soft-tissue regeneration [4].

Before the promise of reducing soft-tissue trauma can be fulfilled, the surgeon must get through three different layers: the skin, the muscles and the joint capsule, not to mention nerves and vessels within in order to exposure the hip joint. An optimal approach should therefore deliver a short skin incision, omit muscle splitting and/or detachment and preserve the joint capsule.

To reach this goal, several issues have to be addressed. First, the skin incision should be kept as short as possible. Next, there should either be none or as little muscle splitting and detachment as possible. The joint capsule should be preserved and there should be an unrestricted view onto the acetabulum and the entrance into the femoral medullary canal.

We hypothesized that a single-incision anterior approach for hip arthroplasty could uphold the premises of minimal invasiveness. Further on, we wanted to know whether this approach can be safely performed and whether there are possible advantages compared to traditional approaches. In the following, we present the data on our single-incision direct anterior approach for total hip arthroplasty.

Patients

One hundred consecutive patients who underwent total hip arthroplasty via the minimally invasive single-incision anterior approach were prospectively followed for at least 12 weeks. No exclusion criteria were applied, neither weight, height, age, gender, previous hip surgery nor secondary osteoarthritis. We enrolled 52 female and 48 male patients, median age was 65.6 years. Total hip arthroplasty was performed on 50 right and 50 left hips.

A body mass index (BMI) >30 was found in 19 patients, BMI 25–29.9 in 35 patients, BMI 18.5-24.9 in 43 and BMI <18.5 in 3 patients.

Five patients suffered from osteoarthritis secondary to avascular necrosis of femoral head, and two patients had osteoarthritis secondary to dysplasia. One patient had osteoarthritis secondary to juvenile septic arthritis of hip joint. Three patients had undergone surgery for dysplasia of the hip (one Chiari pelvic osteotomy, one Ganz pelvic osteotomy, one intertrochanteric varus osteotomy). Two patients had non-displaced medial fractures of the femoral neck.

Surgical Technique

The patients were placed in the supine position on the operating table. This created a predictable stability. No sandbags were used to push the hip forward. The anterior or superior iliac spine was palpated and the gap between the tensor fasciae latae and the sartorius muscle identified. The incision started 3–4 cm distal to the anterior superior iliac spine and followed the anterior border of the tensor fasciae latae muscle. The length of skin incision was approximately as long as half the circumference of the...
cup to be inserted. We carefully dissected down through the subcutaneous fat, making sure to avoid cutting the lateral femoral cutaneous nerve. Next, the deep fascia on the medial side of the tensor fasciae latae was incised. The anterior capsule of the hip could then be identified by blunt dissection. A blunt-tipped curved special retractor was placed laterally around the capsule, overlying the neck of the femur, and a special sharp-tipped curved retractor was placed around the innominate tubercle of the greater trochanter. The sartorius muscle was retracted medially. Care had to be taken not to pull too hard in order to avoid the risk of bleeding from the ascending branches of the lateral femoral circumflex vessels. These vessels were carefully suture ligated or electrocoagulated.

The medial capsule of the femoral neck which is covered by the rectus femoris muscle and fatty tissue was bluntly exposed. The rectus femoris muscle was medially retracted by a sharp-tipped curved special retractor. The rectus femoris originates from two heads: the direct head from the anterior inferior iliac spine, and the reflected head from the superior lip of the acetabulum as well as the anterior capsule. The origin between these two heads had to be transected. Then the hip was slightly bent and the sharp-tipped curved retractor was placed from the anterior rim of the acetabulum medial to the origin of the rectus femoris at the anterior inferior iliac spine. The exposed hip joint capsule was incised using an H-shaped capsular incision. Next, the curved retractors were placed within the hip capsule. The capsule was detached at the inter-trochanteric line as far to the medial and lateral side as possible, thereby clearing the junction between the anterior surface of the neck and the shaft. The lesser trochanter and the junction between femoral neck and greater trochanter were palpated to facilitate orientation for osteotomy of the neck (Fig. 7.8).

The femur was rotated into a neutral position and the femoral neck cut with an oscillating saw according to pre-operative templating with the patient’s radiographs. The level of the femoral cut varied, depending on the anatomy of the femoral neck. A corkscrew extractor was screwed in and the head removed. Occasionally, the head had to be fragmented and removed in piecemeal fashion. The retractor was left on the anterior acetabular rim in place and the others were removed.

The sharp-tipped curved retractor was placed around the transverse acetabular ligament which was sometimes ossified and part of an inferior osteophyte. A second sharp-tipped curved retractor was placed on the lateral ilium and a two-pronged acetabular retractor inserted under the bony rim of the inferior acetabulum. Next, the remnants of the acetabular labrum were excised and the depth of the acetabular fossa defined. Any overhanging osteophytes were excised and synovectomy performed. No capsulectomies were performed.

Since acetabular exposure was excellent and the position of the pelvis could be easily palpated on the table, orientation by direct visualization proved quite simple. Soft tissues were removed from the acetabulum with curettes and rongeurs. The acetabulum was reamed down to the subchondral bone, using angulated reamers designed to protect soft tissue. Cemented as well as cementless cups were used. From this anterior position, it was easy to
establish the exact anteversion which was kept at approximately 15–20° and corresponded to normal anatomy.

A bag was placed under the proximal thigh and the entrance of the medullar channel was brought to the level of skin incision by pulling the calcar up with a hook (Fig. 7.9). Then capsulotomy was performed at the greater trochanter. The two-pronged femoral retractor was placed around the greater trochanter and the femur externally rotated and positioned in a figure-4 position. If necessary, the tendons of the internal obturator and gemelli had to be released near their insertion on the medial side of the trochanter. In such instances, no reattachment was carried out. Following this, rasping of the femoral shaft was started, using angulated rasps. After determining the proper size, a permanent, either cemented or cementless, prosthesis was inserted into the femur. After final reduction, capsular repair was performed using reefing sutures and reattachment at the acetabular rim.

The Accolade femoral system was used in 59 patients and the ABG II cemented femoral system in 41 patients. The Trident acetabular system using a crosslink polyethylene inlay was implanted in 66 patients, an All-poly cup was used in the other 34 patients. Implantation technique was cementless in 52 patients (Fig. 7.10a), cemented in 28 (Fig. 7.10b) and hybrid in 20 patients.
Chapter 7.2 - Minimally Invasive Single-Incision Anterior Approach for Total Hip Arthroplasty - Early Results

The choice of implantation technique was based on subjective estimation of bone quality during surgery.

Results

Median and mean (SD) operating time was 105 (±33) min (range 61 to 270 min). The learning curve showed a decline in the moving average (10 patients) from 125 to 86 min (Fig. 7.11).

Three intra-operative complications occurred, but were not considered to be caused by the surgical approach: one perforation of the inner cortex of the osteoporotic acetabulum, one avulsion of the tip of the greater trochanter and one fissure of the proximal shaft. The perforation of the inner cortex of the acetabulum was treated by an enforcement ring through the same approach. The tiny trochanteric fragment was excised since it was considered too small for reattachment. The fissure went unnoticed intra-operatively until subsidization became apparent on post-operative radiograph, upon which revision surgery was performed by the anterior approach. The Accolade femoral component was exchanged for a cemented ABGII prosthesis and the proximal femoral stem was secured by cerclage through the same approach.

Blood was collected in the cell saver for 93 patients. Median (mean, SD) re-transfused blood was 160 ml (200±210) range 0–900 ml. Collected blood was given in 61 patients, in 32 patients the amount of collected blood was considered too little to justify re-transfusion. In addition, 23 patients received autologous and 3 patients homologous transfusions with an average of 113 ml (0 to 5 erythrocyte blood concentrates). Blood loss was assessed, using the methods of Rosencher et al. [13]. When compared to their results on primary 1122 hip replacements with a median blood loss of 1944 ml (SD ±1165 ml), the blood loss of a median 1566 ml (SD ±1041 ml) calculated for our sample was 25% less. This difference is highly significant (p <0.01).

Naproxen was given for 14 days to prevent heterotopic ossification and additionally served as pain medication. Post-operative opioids were given routinely on the day of operation. On the first post-operative day, however, opioid therapy was only necessary in five patients.

Despite prophylaxis, one patient developed extensive, motion-limiting heterotopic ossification. There were no dislocations or nerve palsies. One patient developed thrombosis of the fibular vein.

Patients were discharged from the hospital an average of 4 days earlier than patients receiving standard conventional total hip arthroplasty (reduction of 36%). Delayed wound healing, located at the distal edge, occurred in three patients, and was due to the fact that only straight reamers were available at the beginning of the study. Nevertheless, no revision surgery was needed, since all wounds healed by granulation and epithelialization within 4 weeks.

One case of deep infection evolved during the first 3 months; the patient refused to undergo revision surgery at our department.

The WOMAC score was assessed before and 6 weeks after surgery. Seventy-eight patients had completed the WOMAC score at the 6-week follow-up. An improvement could be deduced from the median score (mean ± SD) of 43 (43.8±19.2) to 90.4 (87.9±11.6). The median (mean ± SD) pain sub-score at 6-week follow-up was 97 (90.3±15.6).
At the 6-week follow-up, scars measured a median (mean, SD) of 6.75 cm (7.09±1.66) in length, ranging from 4.5 to 11.5 cm. Scar length was 83% (87±19.4) of half the circumference of the cup. Photographs of the scars (Fig. 7.12) were available in 68 patients and were assessed according to Beausang et al. [10]. Based on these images, the median scar quality was rated as 5.9 points (5.7±1.4) range 4.0-5 to 9.45 on a scale of 4 (best) to 24 (worst). On a scale of 0 to 100%, this converted to a median of 8.8% (9.4±1.4%), range 0 to 30.

At the 3-month follow-up, there were no leg-length discrepancies >1 cm in 97 patients. A leg-length inequality of >1 cm and <2 cm was seen in three patients. In two of these three patients, the leg-length discrepancy was the same as before surgery, thus there was only one case of true elongation.

Radiographs were assessed at 3-month follow-up. The median inclination angle was 44.1° (43.5±6.34), range 31°-58°. Median alignment of the femoral component was 0° (0.6° varus ±1), range 3° valgus to 5° varus. There was one case of subsidization, which was due to a fissure of the proximal femur and had to be revised. Four patients expressly complained of numbness in the lateral thigh.

**Discussion**

The aim of minimal invasive surgery is to reduce soft-tissue trauma and thereby operative blood loss, post-operative pain, and hospitalization time while speeding post-operative recovery and improving the cosmetic appearance of the surgical scar [4]. To properly prevent soft tissue trauma, minimal invasiveness must apply to skin, muscles, joint capsules and to the nerves and vessels contained therein.

Minimally invasive hip arthroplasty using an anterior approach can be accomplished through an incision about half the size of the circumference of the cup to be inserted. As exceedingly small incisions tend to be stretched during the procedure, the length of the post-operative scar is the only valid measure.

The anterior approach has been reputed to produce unfavorable scars. This statement is not consistent with our own observations and experience. There is only one truly intermuscular and internervous plane of dissection to access the hip joint, and it lies anteriorly between the tensor fasciae latae and sartorius muscle and gluteus medius/minimus and rectus femoris muscles [14–17]. Anatomically, all other classical approaches to the hip, e.g. anterolateral, lateral, posterior and medial, are either intermuscular or internervous.

With our minimally invasive single-incision direct anterior approach for total hip arthroplasty, perfect exposure of and view onto the acetabulum can be expected. The presumption was that, through a small incision, it would be impossible to sufficiently lever out the femur to implant the femoral component and that visibility would be insufficient. This attitude has led to double-incision approaches and the use of fluoroscopy [1]. In our judgment, there is no need for a second incision or muscle splitting. Nevertheless, exposure of the entrance of the medullar canal demands meticulous detachment of the capsule on the femur, eventually involving partial tenotomies of the obturator internus and gemelli tendons. For this purpose, good anatomical knowledge of muscle attachments on the greater trochanter is mandatory [18–20]. In addition, special retractors facilitate the maneuver.

Moreover, these double approaches were restricted to slim and non-athletic patients. We have successfully implanted hip prostheses via a single incision by the minimally invasive approach even in very obese persons who tend to have less fat in the flexion crease overlying the hip joint. Capsular repair by the minimally invasive single-incision anterior approach is a feasible procedure.

Both cemented and cementless devices can be used on the acetabular side as well as on the femoral side. Acetabular reaming and cup placement may be facilitat-
ed by the use of curved reamers and inserters. Special broach handles and stems make broaching and femoral component implantation substantially easier. Radiographic evaluation provide no evidence of any differences in implant position compared to our records on classical exposures. There was no need for the use of an image intensifier.

There is no mystery to the minimally invasive single-incision anterior approach, although it is imperative to use special instrumentation, such as the retractors, reamers, broach handles and inserts discussed above. In addition, the design of some prostheses is obviously more suitable for this technique than others. The procedure is associated with less pain for the patient who can be ambulated earlier. The need for blood transfusions is usually low.

We did not observe any dislocations, there were no nerve palsies, although four patients reported hypesthesia on the lateral side of the femur indicative of partial laceration of femoral cutaneous nerve.

In conclusion, minimally invasive hip arthroplasty by the single-incision anterior approach is a safe procedure that allows correct placement of acetabular and femoral implants. The exposure is facilitated by the use of special retractors, reamers, broachers and inserters; implantation is made easier with specially designed prostheses. The proposed technique can reduce peri-operative blood loss, post-operative pain, and hospitalization time; it speeds up post-operative recovery and leads to small, cosmetically satisfactory surgical scars. We encourage the conduct of comparative prospective randomized studies to fully evaluate outcomes and benefits.

References