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Minimally Invasive Surgery in Total Hip Arthroplasty

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J. Pfeil • W. E. Siebert (Eds.)

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Preface

We are currently witnessing a marked change in total hip arthroplasty. Minimally invasive surgical techniques have been popularized in the media and patients are showing an increased interest in these techniques, which promise to provide them with an even better result following total hip replacement.

Most people agree that minimally invasive surgery should lessen the impact of the operation on the patient's quality of life. Different techniques are available, and this book will help you to understand the concept of minimally invasive surgery of the hip and the reasons why surgeons choose various solutions to achieve the same goal.

As there are different ways to minimize soft-tissue and muscle traumas, skin incision length, and capsular disruption, this book covers all important approaches to the hip based on history of minimally invasive surgery. It also includes a comprehensive chapter on anatomy. The reader gets first-class information on the anterior, the antero-lateral, and the posterior approach, using different techniques of positioning the patient and different instrumentation.

The history of minimally invasive surgery is important for a complete understanding of these new techniques and the anatomy around the hip. A certain amount of repetition has been included as the new techniques focus on areas that must be described in detail for a better understanding of the techniques and different approaches.

The reader may then decide whether minimally invasive surgery is a winning concept and whether new instruments and new prosthetic designs are required.

The purpose of this book was to assemble a comprehensive collection of current knowledge on minimally invasive arthroplasty technique in the hip.

Our goal was to include all important approaches and to discuss these with experts in that field.

As long as the scientific evidence regarding definitive outcomes lacks long-term follow-up studies, the book assists reconstructive surgeons in their decision-making for an individual patient, helping them to decide which approach and which technique is best for the surgeon and the patient.

Total hip arthroplasty will continue to evolve in directions previously thought not possible.

This book is intended to provide the surgeon with detailed anatomy and technical information to prepare the new operative techniques and decide which approach to use and then assist in the everyday work with these techniques.

In summary, there are a growing number of elderly people with an increasing incidence of arthritis. These older people are better educated and have more information access than was previously the case and – last but not least – these potential total hip patients may have high activity expectations.

The new total hip patient needs new operative techniques that provide him not only in the early days after the operation, but also in the long run, with an optimal result. After operation, the patient will be able to take up his recreational activities without any problems and with full muscle function.

We hope that this book will help to answer the open questions in the field of minimally invasive surgery in total hip arthroplasty.

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Introduction

1

Joachim Pfeil

Minimally invasive surgery (MIS) is rather modern in total hip arthroplasty (THA). Supporters of MIS claim that it offers the surgeon a number of advantages over conventional surgery. Evidence from short-term studies suggests that patients undergoing MIS have better outcome and recover faster than after conventional surgery.

In order to understand how MIS originated, we must first look at the development of modern surgery. The nineteenth and twentieth centuries saw rapid progress being made in all fields of surgery. Surgical advances are discussed in relation to social and technological revolutions which occurred at the same time and acted as the driving force for progress.

1.1 Development of Surgery in General

Surgery advanced more in the last two centuries than at any time, since the Roman era and the days of Galen. The nineteenth and twentieth centuries witnessed revolutionary advances in science, technology and industry. Industrialization introduced technology into society and continues to have a major impact on our everyday lives.

1.1.1 Social Changes

The industrial revolution was not without cost to society and the environment. The demand for manpower to fuel industry attracted people from rural areas into cities. Population increased rapidly in major industrial cities throughout Europe and North America. People were lured by the attraction of better economic conditions in the cities, but most found

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only hardship and poverty. Overcrowding in cities placed a huge strain on rudimentary public health services. Poverty and malnutrition increased the prevalence of many diseases including those causing bone deformities such as rickets and tuberculosis. This cocktail of overcrowding and poverty led to many major health crises such as the London cholera epidemics of the mid-nineteenth century. Public health issues were pushed increasingly into the political arena and this was instrumental in forcing changes in medical practice.

1.1.2 Technological Development

Technology began to play an increasing role in medical practice from about the nineteenth century onwards. There was a renewed interest in improving the microscope, developed two centuries earlier by Antoni van Leeuwenhoek. Using the microscope, scientists were able to demonstrate, for the first time, that all living tissues were composed of cells. This marked a turning point in our perception of the causes and processes of disease. Until then, it was widely accepted that diseases were caused by exposure to "bad air" (miasma theory). Pioneering work by Louis Pasteur and Paul Koch confirmed that many diseases, previously attributed to miasma were in fact caused by microbes (germ theory). The germ theory influenced Joseph Lister who developed an antiseptic system to minimise the risk of infection during surgery. Antisepsis was soon replaced by asepsis, as new technologies were developed with the aim of creating sterile conditions in operating rooms. Advances made in anaesthetics and aseptic technology gave surgeons the confidence to experiment with more daring procedures than previously. There were major advances in material science which led to the development of the surgical instruments and implants used today.

Having looked at the progress achieved in general surgery, we will now focus on how this influenced the development of orthopaedic surgery.

1.2 Development of Orthopaedic Surgery

The term "orthopaedics" is derived from "ortho" (straight) and "paedic" (child) and was first used by Nicholas Andry in the mid-eighteenth century. Andry was interested in developing methods for correcting and preventing skeletal deformities in children. Although his methods were criticised as being unscientific, he is still regarded as the "Father of Orthopaedics".

Orthopaedic surgery became a recognised part of operative treatment for musculoskeletal problems from around the mid-nineteenth century. Previous to this, bone setters had set fractured or broken bones without the need for surgical intervention. Invasive surgery (orthopaedic or otherwise) was associated with high mortality rates. Thus, surgeons only elected to operate when the life of the patient was already endangered. Such was the case on the battlefield, where many surgeons gained their training. Amputation was the only procedure known for dealing with limb wounds which risked becoming septic. Limb amputations were performed quickly to minimise blood loss and the risk of shock to the patient. There was no concept of the need for sterile surgery and many patients died from subsequent infection of their wounds.

The introduction of anaesthetics such as ether and chloroform, and the development of antiseptic and aseptic technologies heralded in the new age of experimental orthopaedic surgery. Techniques were developed allowing joint excision, osteotomies, arthrodesis and bone grafting to be performed. From the beginning of the twentieth century, it was possible to visualise bone fractures and deformities with X-rays. Parallel developments occurred in other branches of medical science which had an impact on orthopaedics. Bone deformities caused by rickets could be prevented with a diet containing adequate vitamin D. The introduction of antibiotics had a significant impact in controlling soft tissue and bone infections. The crippling disease of poliomyelitis was largely eliminated when the Salk vaccine was developed against it.

These advances in disease prevention saw the focus of orthopaedic surgery shift away from treating childhood deformities. Modern orthopaedic surgeons are now faced with the challenge of treating problems in an increasingly elderly and more active population of adults. The orthopaedic problems confronting these surgeons have changed along with the approaches used for treatment.

1.3 Surgical Approaches in Orthopaedics

The earliest approaches in orthopaedic surgery involved making small incisions to minimise the risk of infection. Jacques Delpech was one of the first surgeons to popularise small incision surgery. He treated club foot by performing a subcutaneous tenotomy through a small incision in the skin. The introduction of anaesthetics and antiseptic technology caused orthopaedic surgeons to shift their interest towards making large rather than small incisions. This attitude was nicely penned in the expression “great incisions for great surgeons”. A benefit of using large incisions is that they provide the surgeon with better visibility in the operating field. We could also expect improved visibility to have a positive impact on surgical outcomes.

Orthopaedic surgeons were able to experiment and develop a number of different approaches to the hip joint through large incision surgery.

1.4 Surgical Approaches to the Hip Joint

Modern surgical approaches to the hip joint originate from a lateral approach which was first used by Charles White in the mid-eighteenth century. The lateral approach gained popularity and was the standard for hip surgery until late in the nineteenth century. Modifications to the lateral approach were made by surgeons who began to take advantage of anaesthetics. Bernard von Langenbeck is credited as being one of the first surgeons to use anaesthetics. Langenbeck's experience in the Austro-Prussian war convinced him of the need to break with routine practice and amputate injured limbs only as a last resort to avoid sepsis. This led him to develop a new approach to the hip which offered better postoperative wound drainage than the lateral approach. Langenbeck's posterolateral approach improved wound drainage to such an extent that it reduced the risk of postoperative gangrene and sepsis. The posterolateral approach and the thinking behind it were of considerable importance to military surgeons operating without antiseptics. Although antiseptic technology was available at that time, it did not reach the battlefield until the early twentieth century.

The introduction of antiseptic and aseptic technologies into mainstream medicine saw a rapid rise in experimental hip surgery. At the end of the nineteenth century, more than twenty five different surgical approaches to the hip had been described.

The anterior approach to the hip was first developed by Maximilianus Schede and Karl Hueter during the mid-nineteenth century. Marius Smith-Petersen is credited with popularising this approach during the early twentieth century. Smith-Petersen developed the anterior (Smith-Peterson I) and anterolateral (Smith-Peterson II) approaches that are well known today. Reginald Watson-Jones introduced a variation of the anterolateral approach which he found suitable for treating femoral neck fractures. The posterolateral approach of Langenbeck was modified by Theodor Kocher and Alexander Gibson. The Gibson approach was later developed into a new low posterior approach by Austin Moore.

These conventional anterior, anterolateral, posterolateral and posterior approaches are popular among surgeons today. For each conventional approach, an equivalent minimally invasive approach has been developed.

1.5 Minimally Invasive Surgery

Minimally invasive surgery (MIS) has grown in popularity over the past 20 years. This is partly the result of rapid technological developments in materials and instrumentation. For instance, the endoscope allows surgeons to perform MIS through small incisions which are otherwise restrictive for conventional surgery. A second reason for interest in MIS is the shorter hospital stay after operations. This is of considerable importance to health care services striving to minimise their costs. Nowadays, a number of therapeutic and diagnostic procedures in different areas of surgery are performed by endoscopy.

The application of MIS to spine surgery represented an important breakthrough for orthopaedics during the 1990s. More recently, there has been a growing interest in MIS for total hip arthroplasty (THA). Surgeons, patients, implant manufacturers and the media have all shown interest in the possibilities offered by MIS. There is a high level of public awareness about MIS owing to extensive media coverage of the topic. However, media coverage often presents only the perceived benefits of MIS. Consequently, there is an increasing demand from patients to have hip replacement by MIS rather than by conventional surgery. A growing number of surgeons would like to provide more balanced information on MIS to their patients. The public debate about MIS continues to be encouraged by implant manufacturers.

As with any new technique, we first need to make a risk/benefit comparison of MIS against conventional surgery.

To understand what is innovative about MIS in THA, we need answers to several questions. The term MIS must be defined and the origin(s) of different MIS approaches, determined. The advantages and disadvantages attributed to MIS require evaluation. Last but not least, it is important to identify any economic benefits offered by the technique.

We define MIS as a technique which aims to achieve the best preservation of soft tissues and musculature of the hip. This involves making smaller incisions for MIS than for conventional surgery. The exact size of these so called "mini" incisions has led to confusion in the literature. Some authors consider the mini incision to be less than 15 cm, while others regard it as being less than 7 cm. On average, most authors agree that 10 cm is the upper threshold for using the term mini incision.

All the MIS approaches to the hip involve modifications made to conventional approaches. In this respect, MIS is not fundamentally new but rather a refinement of conventional surgery. For example, Robert Judet developed a MIS anterior approach which is based on the conventional anterior approach of Smith-Petersen. Also, Heinz Röttinger developed a MIS anterolateral approach based on the conventional anterolateral approach of Watson-Jones.

Conventional THA is one of the most successful surgeries performed. This sets a high standard against which MIS needs to be judged. A number of short-term studies have reported favourable outcomes for MIS when compared with conventional surgery.

For the surgeon, the most important advantages of using MIS compared with conventional surgery are better outcome and postoperative expediency. The good outcome of MIS results from soft tissue management and operating through a small skin incision. Both cause fewer traumas to the skin than conventional surgery. The small incision scar has been well publicised by the media and used as a selling point by implant manufacturers. Not surprisingly, the small incision scar is the most important reason for patients deciding to undergo THA by MIS rather than by conventional surgery.

Less pain, less blood loss, shorter hospital stay, shorter rehabilitation period and faster return to daily routine, are obvious benefits for patients. Shorter hospital stay is also an important cost saving consideration for health care services. Bertin [1] reported cost savings of 4,000 US dollars per patient when using MIS instead of conventional surgery. This represents a total cost saving of around 300 million dollars per year for the entire US [1]. Straumann et al. [2] modelled the economic consequences of performing THA by MIS rather than by conventional surgery in Switzerland. Their model applied a cost-effectiveness analysis of MIS in THA for the US to hospital and rehabilitation costs for conventional surgery in Switzerland [2]. They estimated annual cost savings of €42–70 million for THA performed by MIS rather than by conventional surgery in Switzerland [2].

These benefits attributed to MIS have led to public expectations which are high, but frequently unrealistic. Some surgeons worry that their patients are beginning to perceive THA as a minor surgery. Another misconception among patients concerns the universality of MIS. Many obese patients need to be made aware that MIS is not recommended for them.

A few disadvantages have been attributed to MIS. Some authors argue that MIS increases the duration of surgical intervention, and the risk of perioperative complications.

MIS is a technique which is not recommended for less experienced surgeons. Lack of experience with MIS can increase the risk of inadequate positioning of an implant.

At present, only a few of the studies which compare MIS with conventional surgery are randomised and controlled. Hence, the evidence for or against MIS is often anecdotal. There is clearly a need for more objective and controlled studies. Moreover, it will be interesting to see how the outcomes for MIS and conventional surgery compare in the long-term.

1.6 Conclusions

As with any surgical procedure, the outcome of MIS depends largely on the skill of the surgeon. MIS should only be performed by experienced and adequately trained surgeons. A good theoretical background, cadaver laboratory, and surgeon-surgeon training are mandatory requirements to achieving proficiency in MIS. With proper training, surgeons and their patients should be able to enjoy the full benefits promised by MIS in THA.

1.7 Scope of This Book

Three of the main MIS approaches to THA are described in this book. These are the anterior, anterolateral, and posterior approaches.

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Anatomy of the Hip Joint

2

Joachim Pfeil

2.1 Muscles Surrounding the Hip

The hip joint is completely surrounded by muscles. The functions of the muscles can be inferred on the basis of their paths. The points of origin and attachment of the muscles surrounding the hip are illustrated in Figs. 2.1 and 2.2 (ventral view), in Figs. 2.3 and 2.4 (dorsal view) and 2.5 (lateral view). These drawings also show the attachment of the articular capsule of the hip joint and the position of the epiphyseal cartilage. The reflected head of the rectus femoris muscle is attached to the ventral capsule of the hip joint cranially.

Considering the anatomy of the hip joint for surgical purposes, it is important to differentiate between the superficial muscles and the deep muscles. The superficial muscles at the height of the hip joint consist of the sartorius muscle in a ventral position; lateral to this is the tensor fasciae latae muscle inserting into the fascia of the iliotibial tract, into which the glutaeus maximus muscle leads dorsally. This is shown in the sectional drawing in Fig. 2.6.

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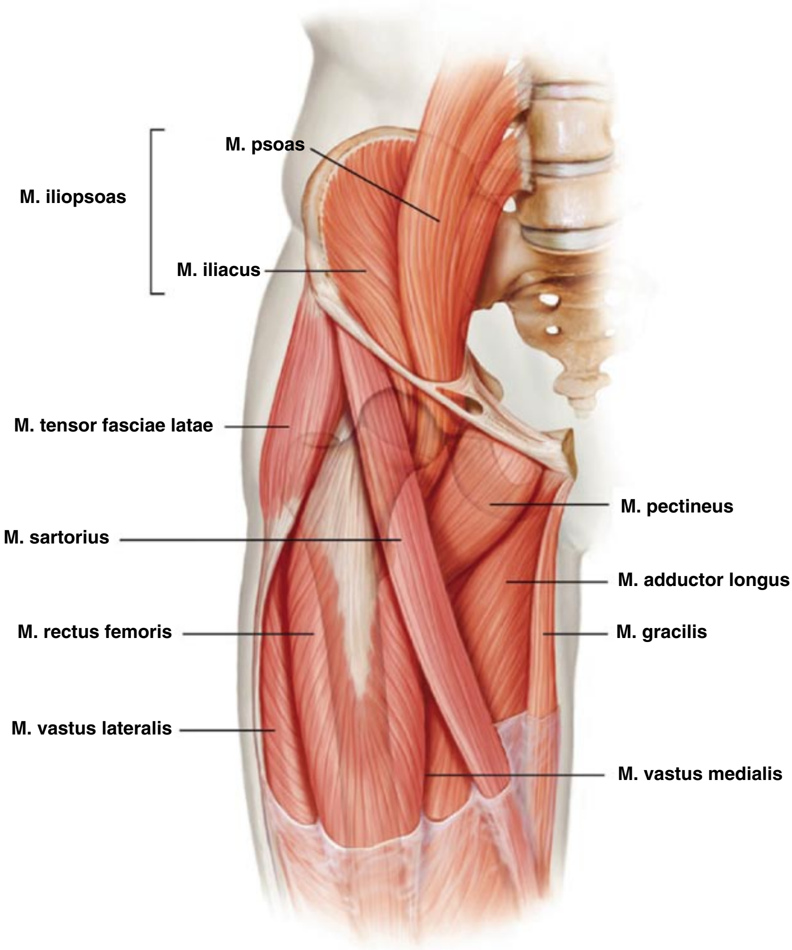

Fig. 2.1 Superficial layer of the muscles – ventral aspect of the hip joint

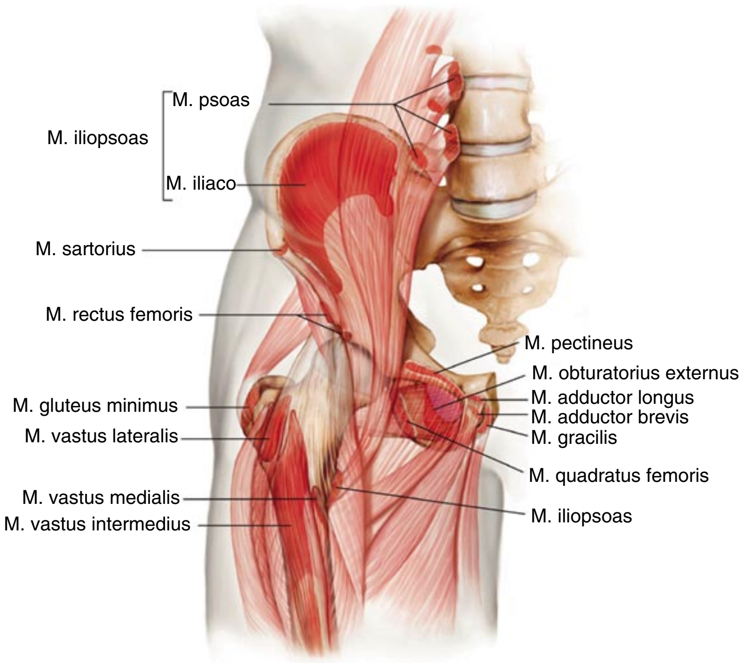

Fig. 2.2 Deep layer of the muscles – ventral aspect of the hip joint

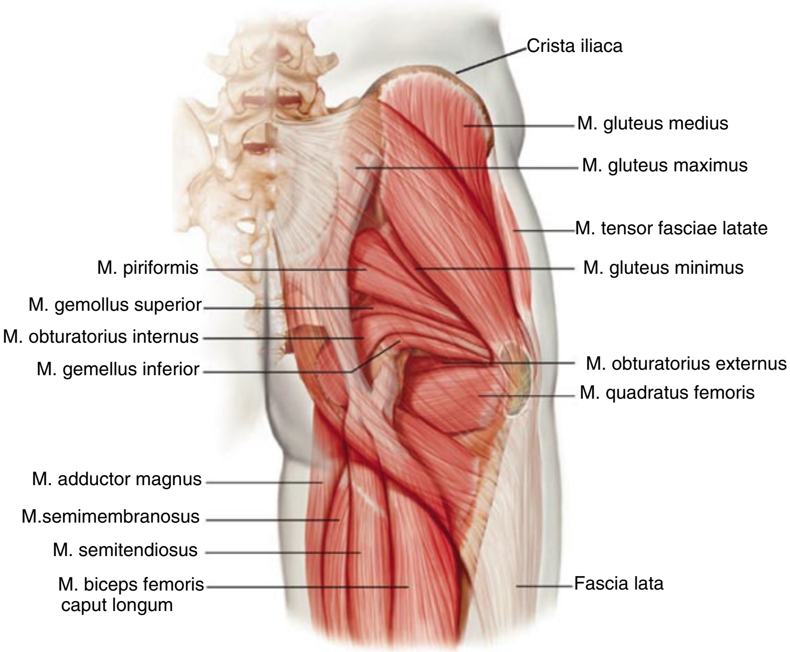

Fig. 2.3 Superficial layer of the muscles – dorsal aspect of the hip joint

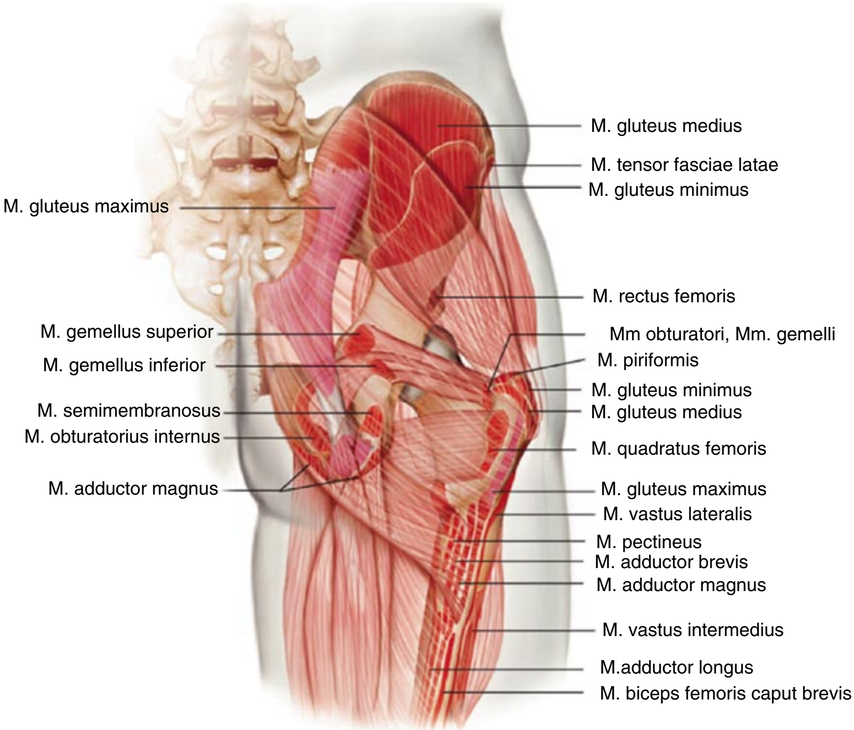

Fig. 2.4 Deep layer of the muscles – dorsal aspect of the hip joint

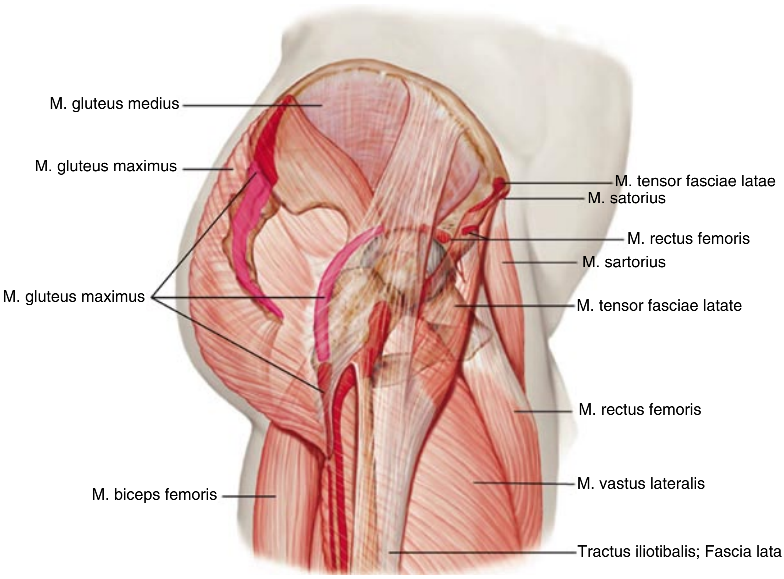

Fig. 2.5 Muscles and fascies – lateral aspect of the hip joint

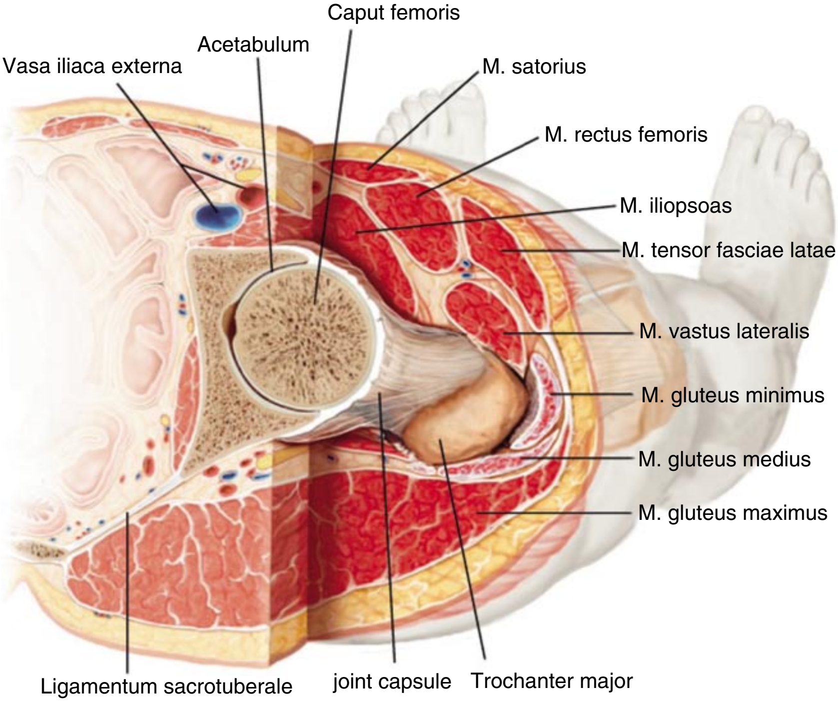

Fig. 2.6 Soft tissues around the hip joint

2.2 Nerves in the Anatomical Vicinity of the Hip Joint

The nerves running in the anatomical vicinity of the hip joint are decisive with regard to the surgical approaches to the joint. It is possible to reach the hip joint safely only if they are not endangered. With specific reference to treatment of trauma, preparatory exposure of the nerves is important for lowering the risk of iatrogenic damage.

Five nerves are of significance when exposing the hip joint for surgery. These are the femoral nerve, the lateral cutaneous nerve of the thigh, the superior and inferior gluteal nerves and lastly, the sciatic nerve, which is the largest nerve in the human body.

2.3 Femoral Nerve (Fig. 2.7)

Origin: The femoral nerve originates in the lumbosacral plexus, made up of the first to fourth lumbar segments.

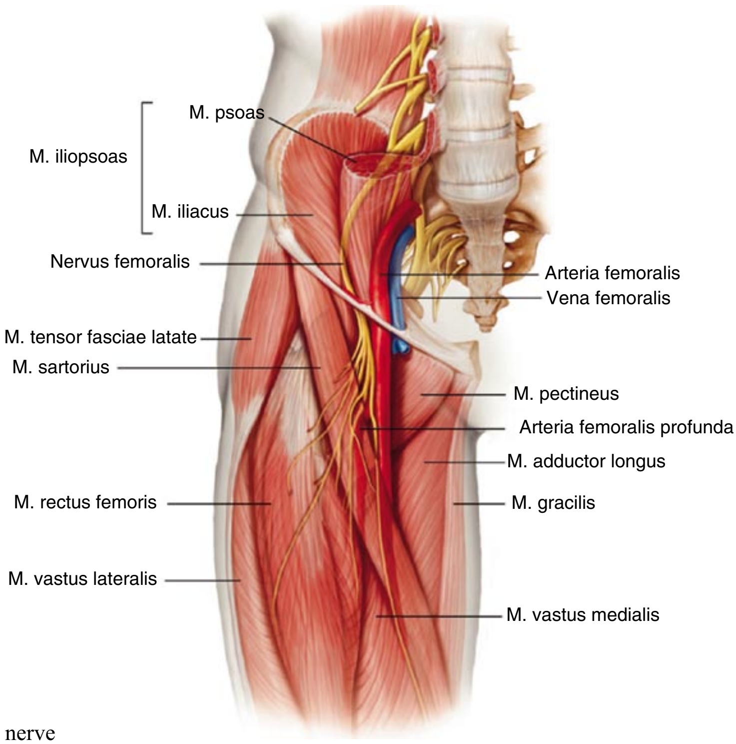

Fig. 2.7 Femoral nerve

Path: The femoral nerve is located laterally to the femoral vein and femoral artery. It runs down along the iliacus muscle beneath the inguinal ligament.

Innervation: The femoral nerve innervates the psoas major and minor muscles, the iliacus muscle, the quadriceps femoris muscle, the sartorius muscle and the pectineus muscle.

Risks: Due to its location ventral to the anterior edge of the acetabulum, this nerve is at risk of pressure-related damage when exposing the joint because of the position of the retractor on the anterior edge of the acetabulum. Direct injury is also possible if, by mistake, entry is made ventral to the psoas muscle. Preparation of this nerve is important for avoiding damage, in particular, when using the ilioinguinal approach. Caudal enlargement of the anterior approach to the hip joint leads to injury of the nerve branches leading into the sartorius and quadriceps femoris muscles.

2.4 Lateral Cutaneous Nerve of the Thigh (Fig. 2.8)

Origin: The lateral cutaneous nerve of the thigh is a purely sensorial branch of the lumbar plexus arising from the second and third lumbar segments.

Path and innervation: The lateral cutaneous nerve of the thigh runs along the iliacus muscle, directly medial to the superior iliac spine and beneath the inguinal ligament, after which it separates into several branches that lead out over the sartorius muscle and through the fasciae, and then branch out further in order to provide the sensory function of the skin of the lateral thigh.

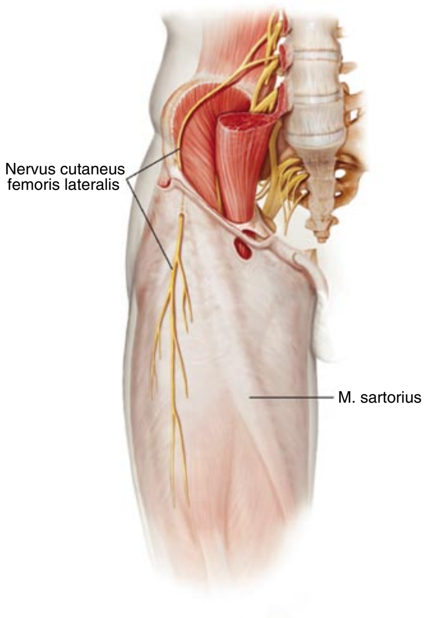

Fig. 2.8 Lateral cutaneous femoral nerve

Risks: With the anterior approach to the hip joint, the nerve is in the immediate anatomical vicinity. In the event of swelling in the hip joint region, in particular, following the trauma of surgery, a direct nerve compression syndrome can occur below the inguinal ligament in the form of paraesthetic meralgia. With the anterior approach to the hip joint, lateralisation of the skin incision by about 2 cm away from the anterior superior iliac spine can considerably reduce the risk of damaging this nerve.

2.5 Superior and Inferior Gluteal Nerves (Fig. 2.9)

Origin: The superior gluteal nerve is a nerve of the lumbosacral plexus arising from the first lumbar vertebra and leading as far as the sacrum.

Path: Together with the artery and vein of the same name, this nerve runs through the suprapiriform foramen, that is, that part of the ischiatic foramen above the piriformis muscle.

Innervation: The superior gluteal nerve consists almost exclusively of motor nerve fibres and innervates the glutaeus medius and minimus muscles as well as parts of the tensor fasciae latae muscle.

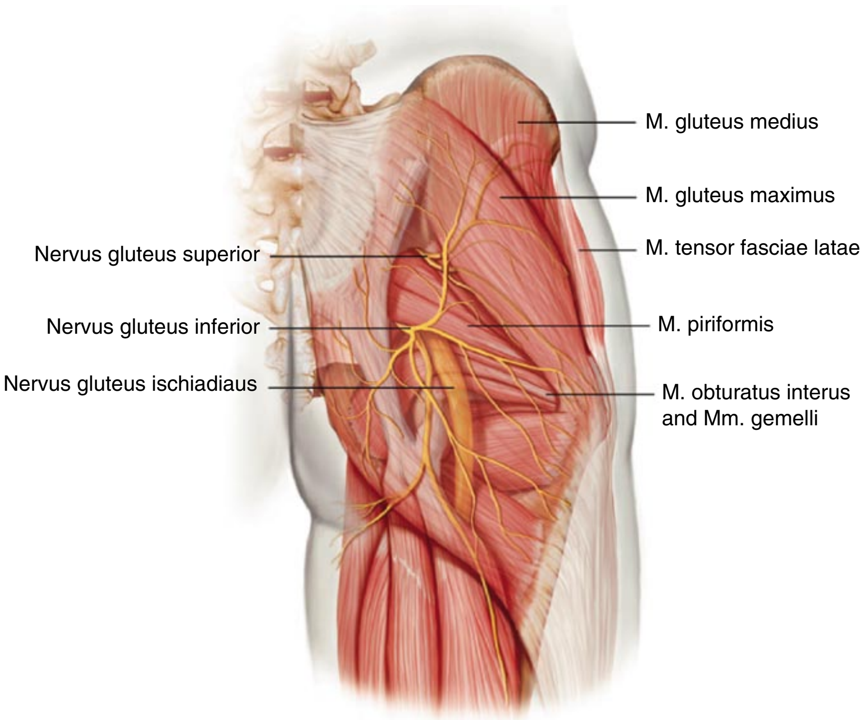

Fig. 2.9 Gluteal nerves

Risks: Dissection of the glutaeus minimus or medius muscles leads to damage to single peripheral branches. There is also a risk of indirect damage due to pressure caused by the retractor. Incorrectly carried out intramuscular injections in the buttock, too, can cause iatrogenic damage to this nerve.

The inferior gluteal nerve also arises from the lumbosacral plexus, leading out from nerve endings L5–S2.

Path: Together with the blood vessels of the same name, the sciatic nerve and the posterior cutaneous nerve of the thigh, the pudendal nerve and internal pudendal artery, this nerve runs through the so-called infrapiriform foramen, that is, that part of the ischiatic foramen located caudally to the piriformis muscle.

Innervation: The inferior gluteal nerve contains almost exclusively motor nerve fibres and innervates the glutaeus maximus muscle.

Risks: This nerve can be damaged by intramuscular injections in the buttock carried out incorrectly. With the transmuscular approach, single nerve fibres serving the peripheral areas are potentially endangered.

2.6 Sciatic Nerve (Fig. 2.10)

The sciatic nerve arises in the lumbosacral plexus, originating from L4 to S5. It runs through the infrapiriform foramen, that is, the part of the sciatic foramen situated below the piriformis muscle. In the region of the hip joint, it lies dorsally against the obturator

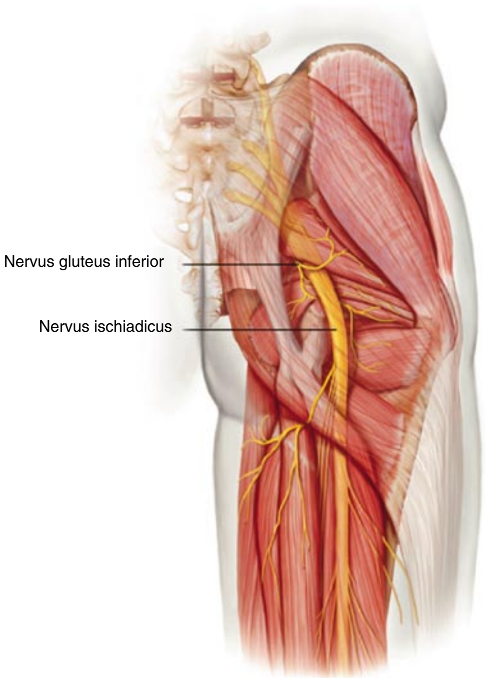

Fig. 2.10 Sciatic nerve

internus muscle and the quadratus femoris muscle. Below the hip joint, it branches out into the common peroneal nerve and the tibial nerve.

Innervation: The sciatic nerve supplies most of the thigh muscles: the gemelli, the quadratus femoris, the obturator internus, the biceps femoris, the semitendinosus and the semimembranosus. If this nerve is damaged, motor and sensory damage to the lower leg and to the foot region will also result.

Risks: Neuroparalysis is a frequent occurrence associated with fractures of the pelvis or the femur or dislocations of the sacroiliac joint. Iatrogenic damage to this nerve can be caused by intramuscular injections and also by pressure caused by the retractor, in particular, when the posterior or posterolateral approaches to the hip are used.

The hip joint can be reached by means of several different approaches (Fig. 2.11). The nerves and blood vessels surrounding the hip joint, in particular, condition the choice of possible approaches. Almost all surgeons favour an approach based on their own training and experience and on their interpretation of published results. Particular diseases and also the use of the various different implants and instruments may often be associated advantageously with specific approaches. All approaches to the hip joint have many years of history behind them. In recent years, interest in small "minimally invasive" approaches has rapidly increased. All these minimised approaches are based on the previously known approaches. Many are named after several different authors. Any comparison between different approaches is difficult, for a number of reasons. For example, no standard terminology has been developed up to now for classing the various different techniques. Accordingly,

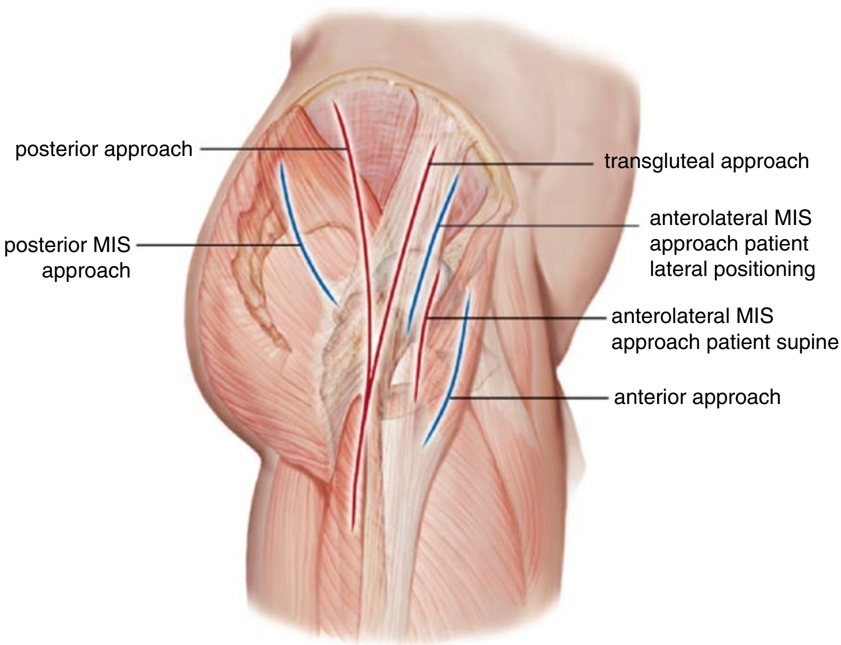

Fig. 2.11 Skin incisions for THR surgery

there is no precise linguistic usage. Expressions such as transgluteal, direct lateral or anterolateral are used by many surgeons and also by authors to indicate both different and the same procedures. Published descriptions are often short and accompanied by very few illustrations or none at all. The surgical anatomy of the hip joint is not univocally described in the orthopaedic literature. What is more, the approaches also differ in terms of skin incision and of management of the superficial and deep muscles as well as the articular capsule.

An anatomical classification is therefore helpful. To make the following table easier to understand, the best-known authors are indicated with the anatomical nomenclature. Therefore see also the references.

Anatomical definition	Anatomical description	Classical authors	MIS authors
Posterior	Splitting of glutaeus maximus muscle	Moore, Osborne, Kocher Langenbeck "Southern approach"	Wenz, Sculco, Roth, Nakamura
Posterolateral	Between glutaeus maximus muscle and fasciae latae	Henry, Marcy and Fletcher	Goldstein
Transgluteal	Splitting of glutaeus medius muscle	Bauer, Hardinge, Learmonth	Berger, Higuchi
Transtrochanteric	Trochanteric osteotomy	Ollier, Vidal, Digastrique, Courpied	Ganz
Anterolateral	Between glutaeus medius muscle and tensor fasciae latae muscle	Watson Jones, McKee Farrar	Röttinger, Jerosch, Pfeil
Anterior	Between tensor fasciae latae muscle and sartorius muscle	Smith-Peterson, Hüter, Judet	Lesur, Keggi, Matta, Rachbauer
Medial	Medial approach with separation of adductor longus muscle	Ludloff, Thomas and Benecke	
Two-incision	Two ways to the joint		Irving, Berger Wetzel

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Complications

3

Joachim Pfeil

3.1 Complications

3.1.1 Pre- and Intra-Operative Events

There are a number of intra-operative complications which can occur during total hip arthroplasty (THA).

The femur can fracture, if the hip is dislocated prior to cutting the femoral neck *in situ*.

There is the risk of over reaming the medullary canal of the femur with a fixed handle rasp because the crest of the femur can be impinged.

Using a rasp with a straight handle or an oversized rasp risks fracturing the greater trochanter.

Bone lysis from secondary aseptic loosening can also significantly compromise the strength of the femur and lead to a fracture.

Cerclage fixation is used to treat femoral fractures due to the above mentioned complications.

Over reaming of the acetabulum can occur during power reaming, if this procedure is not done carefully. The progress of reaming needs to be checked at frequent intervals.

The use of a straight instrument to position the implant can lead to malpositioning of the hip cup prosthesis (either too vertically or too anteriorly).

Arterial injuries have been reported in 0.1–0.2% of all THA. These injuries are mostly caused by impingement from acetabular fixing screws and the placement of retractors in the incision cavity [1].

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Nerve injuries have been reported in 1–3% of all THA, and involve sciatic and/or femoral palsy. The majority of these nerve injuries are only partial and many will resolve without treatment. Women appear to be at a significantly higher risk of developing THA-associated nerve injuries than men [1].

3.1.2 Post-Operative Events

A number of complications can occur post-operatively.

Orthopaedic complications include heterotopic ossification within the pericapsular area of the affected hip joint. Ossification occurs in approximately 50% of cases, and one third of these are clinically significant (leading to failure of the prosthesis) [1]. Implanting can also lead to stress shielding in which changes occur in local bone stresses.

Aseptic loosening of the prosthesis can occur due to osteolysis of the bone. This is often influenced by the material of the implant and its failure to osseointegrate. Loosening may eventually lead to migration of the prosthesis.

Superficial wound infections or deeper joint infections are possible if patients are not treated with prophylactic antibiotics during the intra-operative period. Superficial wound infections may respond to treatment with antibiotics. Severe joint infections, however, may lead to removal of the prosthesis.

Muscle rupture and hip dislocation can occur in those patients engaging in strenuous or sudden movements of the lower body during the rehabilitation period. The gluteus muscle can detach from the trochanter. Furthermore, rupture of the gluteus muscle can occasionally lead to trochanter fracture.

General post-operative complications include deep vein thrombosis (DVT) and embolisms.

DTV are reported to occur in 40–60% of patients who undergo THA without receiving adequate prophylactic treatment against thromboembolic events [1]. Prophylactic treatment agents to prevent DVT include warfarin, mini-dose heparin, low molecular weight heparin, enteric-coated aspirin, and dextran. Meanwhile new oral drugs (dabigatranetexilat and rivaroxaban) are available. They are as effective as conventional medications and easier to use. AV- Impulse systems are as effective as medical treatment agents [3]. The combination of both is recommended. Compression socks during and after surgery have also proven effective in minimizing the risk from DVT.

The application of polymethylmetacrylate bone cement (PMMA) to the femur is also a risk factor for pulmonary embolism [2].

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Patient Selection, Indications and Contraindications

4

Joachim Pfeil

4.1 Patient Selection

The patient's wish for treatment is usually driven by pain.

Selection of patients for general hip surgery involves not only a correct diagnosis of the orthopaedic condition but also the evaluation of the patient's general health.

4.1.1 Examination

For this chapter, we assume that the general health and clinical condition of the patient are examined.

Despite recent advances in imaging technology, normal X-rays are still the basic tool for diagnosis and for pre-operative planning (i.e. measurements for correct insertion and optimal size of prosthesis).

With the X-ray beam centred on the symphysis, it is possible to visualise the upper margin of the femur. In this position, a slight internal rotation applied to the foot enables the shape of the femur to be determined. Full sized plain (non-contrast enhanced) radiographs (356 × 432 mm) provide a template from which line drawings showing the correct alignment of the prosthesis can be prepared. According to Lesur and Müller (personal communication), the successful implanting of a prosthesis depends on the ability of the surgeon to correctly interpret these plain radiographs (Fig. 4.1).

The femur should also be evaluated for adequate length, good muscle condition, and flexibility of movement in different planes.

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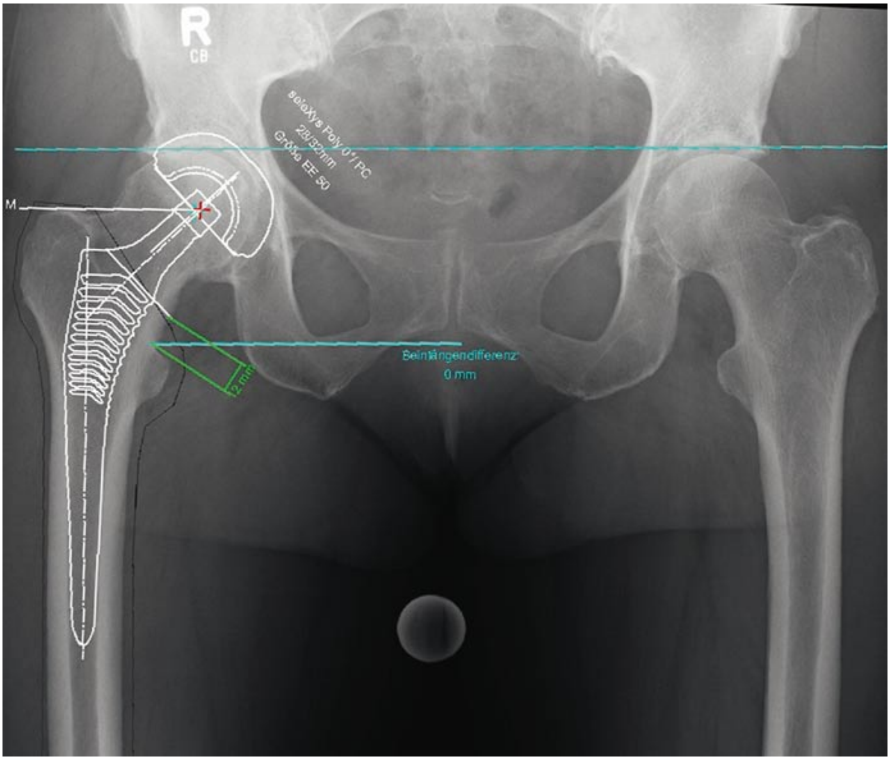

Fig 4.1 Digital planning enables the surgeon to chose the type and seize of implants as well as their positioning. This enables to keep the leg length and the femoral off set

4.1.2 Indications

Pain is the driving factor for patients to ask for treatment. The underlying orthopaedic conditions leading to THA include degenerative joint diseases (e.g. arthrosis or osteoarthritis), inflammatory joint diseases (e.g. rheumatoid arthritis, tuberculosis), avascular necrosis of the femoral head, and bone tumours. Loosening of a previously implanted hip prosthesis which requires revision surgery is also included. Osteoporosis and femoral neck fractures are particularly frequent indications in elderly patients.

Less commonly encountered indications for THA include osteochondritis, osteomalacia (adult rickets), osteomyelitis and Paget's disease.

4.1.3 Contraindications

The most important joint-related contraindications for THA are congenital and developmental joint deformities.

Patients with congenital high dislocation (CDH) are susceptible to developing arthritis at an early age and require extensive reconstruction of the upper femur to correct this deformity. Reconstruction, however, involves a proximal femoral osteotomy. This demands a specific method of hip surgery that would go beyond the scope of this book [1].

Patients with lumbar hypolordosis (i.e. lumbar fusion) move their lower body through the coccyx region rather than the pelvic junction. This condition can be a contraindication for THA.

Previous surgeries performed on the lower back can also be a contraindication for THA.

Previous operations on the knee, the presence of varus or valgus gonarthrosis and other abnormalities which alter the normal angles of the femur all need to be corrected before a THA is performed.

Potential contraindications are presence of a neurotrophic joint, abductor muscle loss, and progressive neurological disorder (e.g. Alzheimer's and Parkinson's disease).

There are several joint-unrelated medical conditions that could qualify as contraindications: a history of heart (e.g. thrombosis) or lung problems, a history of metabolic disorders (e.g. untreated or uncontrolled diabetes), impairment of liver or kidney function, an active systemic infection, dental caries, genital infections, and tolerance of anaesthesia (local or systemic).

All medications taken by the patient need to be reviewed pre-operatively. Treatment with anti-inflammatory (e.g. aspirin) and blood thinning (e.g. warfarin) medications may need to be adjusted or temporarily discontinued.

Addictive habits of patients need to be recorded in the anamnesis. Nicotine exerts a vasoconstrictive effect on blood vessels to the hip joint. This has a negative impact both, on osseointegration of the prosthesis and on wound healing [2].

Similarly, excessive alcohol consumption is known to have a negative impact on wound healing [3].

Extreme obesity can be a contraindication. In general, subcutaneous fat in overweight patients can interfere with accessibility to the joint during minimally invasive surgery. In addition, these overweight pati ents have an increased risk of post-operative dislocation of the hip.

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The Anterior Approach[1]

5

Etienne Lesur

5.1 Introduction

Minimally invasive total hip arthroplasty (THA) by the anterior approach is based on a resection-reconstruction technique that was pioneered by Robert Judet in 1947 [1–3]. Judet developed the technique in post-war France, at a time when surgeons were faced with an increased number of patients presenting with femoral neck fractures. He was able to use the experience gained from these pelvic operations in order to improve on the conventional anterior approach for hip arthroplasty, which until then had relied on larger incisions [4].

We agree with Judet in recognizing that the anterior approach had a number of important surgical advantages [1, 5]. This approach allowed for the closest access to the hip, followed by an inter-nervous plane, and maintained the muscles undisturbed. By applying the Hueter incision procedure to the anterior approach, Judet was able to achieve excellent outcomes with regard to post-operative recovery of function and reduced levels of pain [1]. For the anterior approach, we advocate using an orthopaedic fracture table that was originally designed by Judet [1, 5].

The MIS anterior approach has been used by Lesur and co-workers since 1993 [6], and their findings are described in this chapter. Lesur [6] has based his approach on the original technique of Judet [1], and later modifications by Letournel [7]. Over time, he simplified this technique, which allows peri-operative complications to be minimised.

[1]Please make yourself familiar with the handling of the instruments, the product-related surgical technique and the warnings, the safety notes as well as the recommendations of the instruction leaflet before using an implant manufactured by Mathys Ltd Bettlach. Make use of the Mathys user training and proceed according to the recommended surgical technique.

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By taking advantage of modern developments in prosthesis design, material composition and specially designed surgical instrumentation used for implanting, Lesur (a fellow of Letournel) has succeeded in improving upon the original technique of Hueter.

Lesur [6] identified structural landmarks that act as a road map into the hip. This makes the MIS anterior approach relatively easy for any surgeon who is reasonably well skilled in dissection and minimal invasive surgery.

Currently, patients undergoing THA by the MIS anterior approach of Lesur [6] may expect to walk on the same day only hours after the operation, have a shorter hospital stay, and have less post-operative pain. This facilitates their rapid rehabilitation and return to daily activities.

5.2 Patient Selection

5.2.1 Examination

The pre-operative examination of the patient is conducted as usual. Full-sized plain (non-contrast enhanced) radiographs (356 × 432 mm) are made of the pelvic region, with the central beam focused on the symphysis to allow a view of the acetabulum and the proximal femur. These radiographs allow accurate pre-operative planning (magnifying ratio is 1:1.15).

5.2.2 Indications

The MIS anterior approach is suitable for all patients (active or sessile) of any age. This approach has been successfully applied to patients as young as 26 years.

In general, joints tend to become flaccid or lax in adults over 50 years. Indeed, patients with an active lifestyle may begin to show indications for THA from this age. The MIS anterior approach carries no risk of posterior dislocation and gluteus weakness, and is thus suitable for maintaining a good quality of life in all patient groups. Sitting on a chair or in a car does not provoke posterior instability.

A significant number of middle-aged patients present with femoral neck fractures, but have otherwise normal acetabular sockets. The MIS anterior approach is easily performed in these patients.

While a low body mass index (BMI) facilitates the MIS anterior approach for THA, it should be noted that even a high BMI is not a contraindication for this technique.

Although this surgical technique does not have a limiting factor over time, the anterior approach permits revision surgery to be performed. Importantly, revisions using the anterior approach can be performed on prostheses implanted using other surgical approaches. Bilateral THA using the anterior approach is also possible in one surgical operation. However, the anterior approach does not allow revisions of cemented stems.

5.2.3 Contraindications

Contraindications are the same as for conventional THAs. The most important ones with respect to the anterior approach are congenital high dislocation of the hip (CDH), any surgery requiring additional femoral osteotomy, any revisions to a cemented stem, and a previous ipsilateral colostomy.

5.3 Advantages

The patient is reclined in a supine (dorsal decubitus) position, which provides good surgical access to the hip through a mini-incision (8–10 cm). In comparison with other positions, the hip lies more superficially and the subcutaneous fat layer is also thinner.

Compared with conventional surgery, there is no necessity to detach muscles from the bone when using the MIS anterior technique. The latter preserves pelvic and femoral muscle attachments as well as the hip muscle.

There is no contact with the sciatic or the femoral nerve. Exceptionally, contact with a sensory and peripheral branch of the lateral femoral cutaneous nerve may occur. Retractors are not placed in the pelvic cavity and the surgeon is less likely to compress vessels using the MIS anterior approach described in this chapter. This reduces the occurrence of thromboembolic events.

The MIS anterior approach facilitates improved control of acetabular prosthesis positioning and leg length, allows the placement of cemented and uncemented stems, facilitates bilateral THA during the same surgical operation, and requires no special precautions against post-operative posterior dislocation.

Patients experience less post-operative pain associated with the MIS technique, and show less bleeding than would be expected from a larger incision. The amount of bleeding is normally higher when an uncemented stem (compared with a cemented stem) is inserted into the femur. Extensive bleeding can also occur when the hip joint is affected by an inflammatory disease.

Post-operative infections are rare and are generally superficial in nature using the MIS anterior approach. Lesur did not encounter any deep infection using the anterior approach. This may be related to the larger distance placed between the incision and perineal area of the patient as compared with other approaches. Covering the genital area to guarantee intimacy of the patient may also reduce the incidence of post-operative infections.

A short hospital stay (2–6 days) is associated with the MIS technique compared with conventional surgery by the anterior approach. Indeed, patients are encouraged to walk within several hours following THA, and in some cases, may be fit enough to be discharged from the hospital on the same day.

A short hospital stay results in significant cost savings both to the patient and to the health provider.

Post-operative recovery time depends on a number of factors including the age and previous health of the patient. In general, patients treated by the MIS anterior approach show a faster recovery time (2–8 weeks). Use of the MIS anterior approach enables patients to rapidly return to their daily activities.

Last but not the least, the incision scar produced by MIS is less visible than with conventional surgery.

5.4 Disadvantages

The MIS anterior approach is associated with only one relatively minor disadvantage. Most important is the risk of damage to a peripheral branch of the lateral femoral cutaneous nerve during surgery (mentioned previously). Symptoms include dysethesia, which normally resolves or the patient becomes desensitised to the feeling within approximately 6 months after surgery.

The MIS anterior approach is extendable proximally for the acetabulum but distally only as far as the femoral neck.

5.5 Patient Positioning/OP Field

5.5.1 Patient Positioning

The patient is placed in a supine position on an orthopaedic fracture table with two extension arms of which at least one needs to be mobile in all directions. It is essential that the pelvis is properly balanced and in a horizontal position. The pelvis is then stabilised to prevent movement during the operation. This is achieved by blocking downward movement of the pelvis with a perineal support. A support not exceeding 8 cm is recommended, so that muscle movement is not disturbed during surgery. The feet are placed in special shoes allowing slight traction to be applied to both legs.

The extensible arm of the limb on the side to be operated may be used to apply external rotation and lowered to the ground without using traction. This hyper extends the hip and facilitates exposure of the femoral stump for surgery. Therefore it is difficult to perform the operation without using an orthopaedic table.

An incision drape extending from the iliac crest to patella is used to cover the hip of the patient. The intimacy of the patient is not compromised as the genital region remains covered during the operation. The arm of the patient on the ipsilateral side of the hip is crossed over the head.

Spinal or epidural regional anaesthesia is adequate for 4–6 h. Anxious patients and/or those who may be disturbed by sound during the operation can also be given mild sedatives. General anaesthesia might also be considered.

Compression socks should be worn by the patient during and after the operation in order to reduce the risk of deep vein thrombosis (DVT).

Only two assistants are required to attend the surgeon performing a THA by the MIS anterior approach. One "scrubbed" assistant attends to the operation while the second "unscrubbed" assistant attends to positioning of the extension table.

5.5.2 Surgical Instrumentation

A number of specialised surgical instruments are preferred for the MIS anterior approach. In general, instruments with long handles and long blades are needed. These include long scalpels, a long electrocauterizing tool, long saw blades of 11 cm length, and three types of retractors.Autostatic retractors with long and soft blades (4 cm wide × 5–7 cm long) so-called Cobra retractors (Hohmann No. 7 and standard retractors No. 1) are preferred. The Charnley frame is not recommended, as the strong blades may cut through the tensor fascia lata and iliopsoas muscles. This would risk damaging the femoral nerve.

A femoral head (cork-screw type) extractor, and a special two-pointed retractor for cutting the femoral neck are referred to in Sect. 6.2.

The Chana reamer is important to allow for a correct preparation of the acetabulum and for correct positioning of the cup. A special curved cup impactor (long rod) is used for final impaction. This impactor provides good transmission of force from the hammer to the implant, while reducing interference with the wound edges.

Anatomic rasps are used to start reaming the femur and open the medullary canal. Two types of rasps are available and are shaped to suit the curvature of either the right or the left femur. Use of such rasps helps to avoid perforation of the shaft.

A specific rasp impactor can also be used to impact the straight stem rasps. This rasp holder can be replaced if the latter instrument starts to impinge on soft tissue during final stages of preparing the femur.

Use of fluoroscopy allows the surgeon to check the neck cut of the femur so that when the stem is implanted it does not adopt a varus position, as well as to control the insertion depth and inclination of the cup. The C-Arm is especially recommended for the inexperienced surgeon, and may be used to check the progress of rasps within the medullary canal, as well as the final position of the implanted stem.

Instrumentation used for implanting a hip prosthesis is normally specific for a particular brand of prosthesis and is supplied by the manufacturer of that brand.

5.5.3 Hip Prosthesis

The choice of implants to be used depends on the indication, and on the preference of the surgeon. In general, any good quality cemented or uncemented prosthesis can be implanted using the MIS anterior approach.

However, prosthetic stems should not be too long nor the shoulder too broad, in order to avoid the risk of varus positioning and fracturing the greater trochanter. The femoral head should be of an adequate size to support pressure on the joint with lowest friction between the head and inlay.

A range of cemented and uncemented acetabular hip cups may be implanted, although press-fit cups with a ceramic inlay are recommended by the authors.

5.6 Surgical Technique

5.6.1 Incision and Approach

With the patient in a supine position, the iliac crest of the pelvis is palpated in order to locate the anterior superior iliac spine. A guideline is then drawn from the iliac spine to the middle of the lateral condyle of the femur. A skin incision is made lateral to the iliac spine (by one finger width), and continues 8–10 cm downward and parallel to the guideline (Fig. 5.1). A longer incision is rarely required even for obese or very muscular patients.

The underlying subcutaneous fat is incised and then electrocautery is applied to the skin incision to produce haemostasis. Electrocautery begins with the coagulation of two small arteries in the proximal part of the incision, and continues carefully until haemostasis has been achieved (Fig. 5.2).

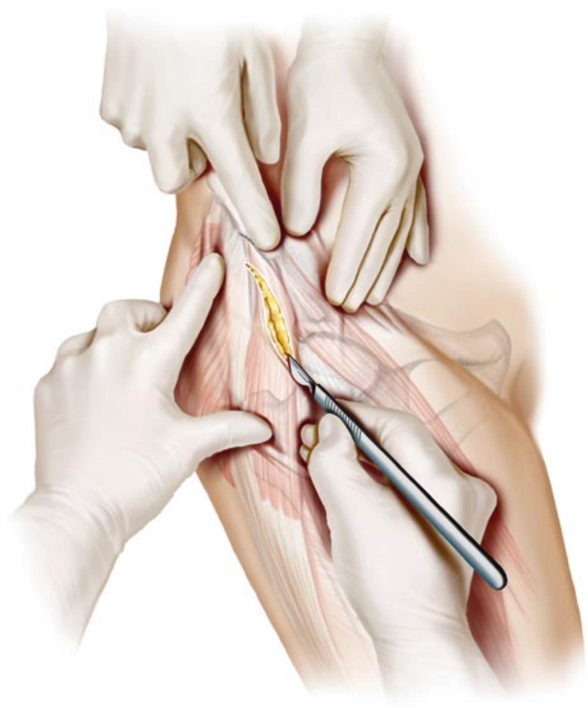

Fig 5.1 Skin incision for the anterior approach lateral to the guideline between spina iliaca anterior superior and head of the fibula

Fig 5.2 Incision of the tensor fascia lata

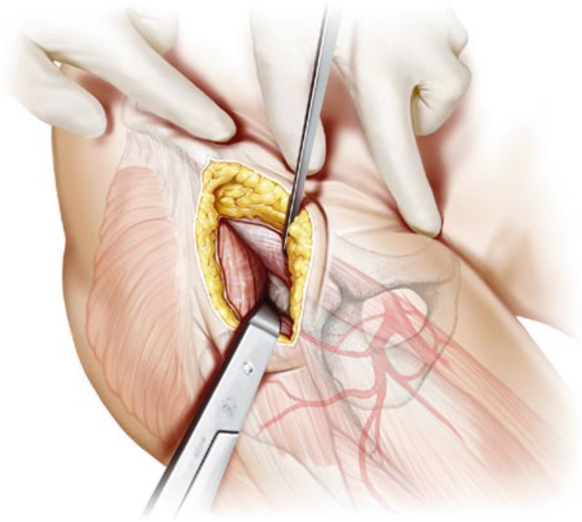

Fig 5.3 Blunt disection of the intramuscular space and positioning of a retractor (care must be taken not to damage the femoral cutaneous nerve)

After checking alignment vs. the iliac crest with the finger, the sheath of the tensor fascia lata is opened in the middle third of the incision. The tensor fascia lata lies within the exposed musculature and is identified by the oblique and laterally oriented muscle fibres. The medial edge of the sheath is raised with forceps, and a blunt dissection (ideally with a finger) is used to gently widen the inter-muscular space separating it from the sartorius muscle. A retractor is then inserted into the cavity to medially displace both the sartorius muscle and the femoral cutaneous nerve that passes over it (Fig. 5.3). Care is taken not to damage this nerve.

The superficial aponeurosis (sheath) of the tensor fascia lata is raised by forceps, and a longitudinal incision is made along the entire exposed length of this muscle to the iliac crest. The internal edge of the superficial aponeurosis is raised with forceps, and a blunt instrument is used to release the muscle from the aponeurosis over its anterior underside. The tensor fascia lata is displaced laterally with a 4 cm long retractor to expose the underlying rectus femoris muscle.

The rectus femoris can be identified from the distal orientation of its muscle fibres. The innominate superficial aponeurosis of the rectus femoris is incised, and the muscle belly retracted medially, to expose the underlying translucent circumflex bundle of vessels in the distal margin of the incision. This deep aponeurosis is opened with a scalpel. The exposed vessels can be visualised using a Lambotte retractor to remove fatty tissues and are then identified, clamped over two clamps and ligated (Fig. 5.4). The ligation thread is deliberately kept long in order to act as a landmark for the distal margin of the incision. The vessels themselves may vary in number, volume and location depending on the individual patients.

The reflecting tendon (pars reflexa) of the rectus femoris muscle can be identified by following the threaded fibres of the rectus muscle proximally in the proximal margin of the incision, and is transsected using an electrocauterizing tool (Fig. 5.5). Cutting the tendon avoids the necessity to balance pressure with a strong retractor in the pelvic cavity, as this might otherwise damage the femoral nerve and iliopsoas muscle. Both the tensor fascia lata and iliopsoas muscles are weaker than the rectus femoris muscle. Therefore, only two blunt bladed autostatic retractors are used to separate the tensor fascia lata laterally and rectus femoris iliopsoas muscles medially in the cavity.

Fatty tissue located underneath the innominate aponeurosis is carefully removed to expose the underlying iliopsoas muscle. This muscle covers the anterior surface of the joint capsule, and the area of coverage varies between patients. The perimysium (sheath)

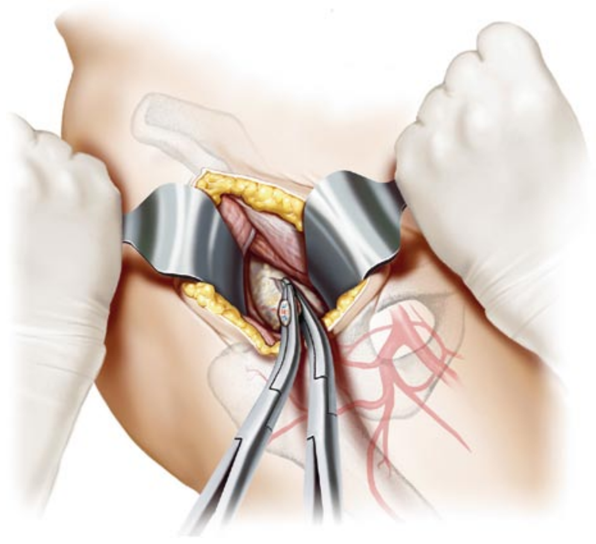

Fig 5.4 Exposure of the bundle of circumflex vessels in the distal margin of the incision and ligation with two clamps

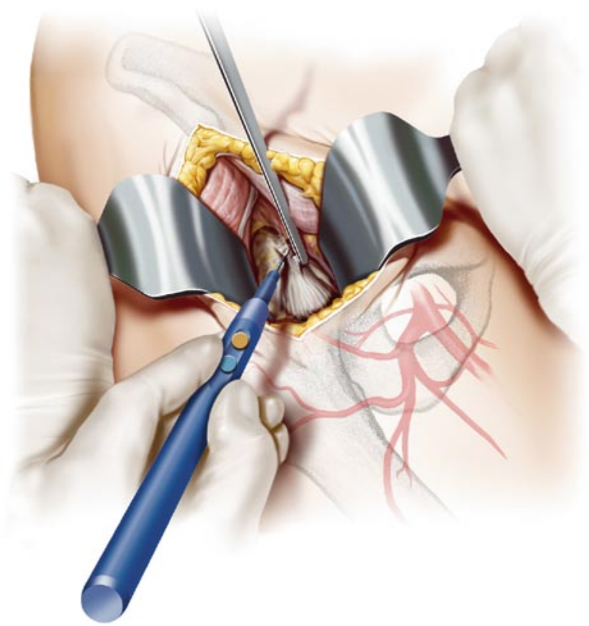

Fig 5.5 Transsection of the pars reflexa of the rectus femoris with electrocauterization

of the iliopsoas muscle is incised, and a Lambotte retractor is placed under and around the neck of the femur.

The two Hohmann retractors are placed as follows: the first Cobra retractor inferiorly and medially to the capsule, the second straight superiorly at the border of the capsule. An autostatic retractor is positioned in between, spreading the following muscles: medially the rectus femoris and iliopsoas, and laterally to the tensor facia lata muscle.

5.6.2 Preparation of the Femoral Neck

An anterior capsulectomy (approximately 40% of capsule area) is performed in order to expose the femoral neck. The L shaped incision of the capsule starts from the fibrocartilaginous anterior labrum and is excised as close as possible to the bony anterior edge of the acetabulum. This allows the superior border of the neck and the junction between the neck and the greater trochanter to be located. The inferior edge of the neck is exposed. Two fat pads are then removed to expose the capsule under the vastus lateralis muscle at the anterior intertrochanteric line. The anterior capsule is removed as close as possible to the vastus lateralis muscle, which should contract during the use of electrocauterizing tool. This indicates the surgeon that the femoral neck is sufficiently exposed for the neck osteotomy cut in situ (Fig. 5.6).

There are three main reasons for removing the anterior capsule. First, the operation is easier to perform after removing this portion of the capsule. Second, the anterior capsule acts like a random pattern flap in which the risk of necrosis may be high. Tissue necrosis

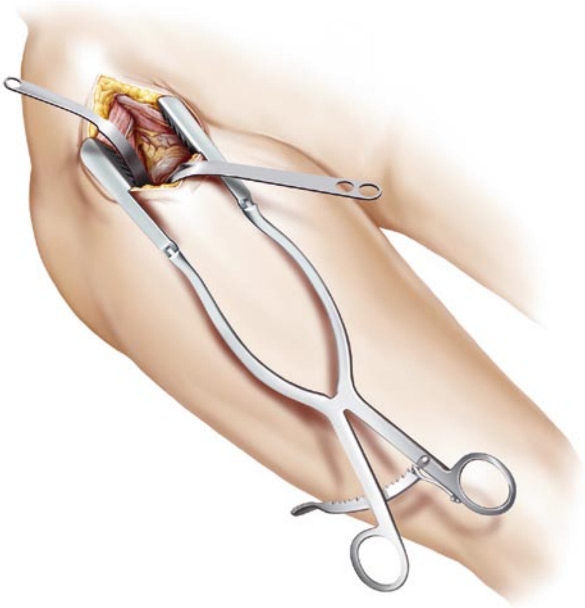

Fig 5.6 Esposure of the femoral neck ready for neck osteotomy

could subsequently lead to an infection. Third, in the event of a post-operative anterior dislocation of the hip, the capsule could interpose between the acetabulum and the head. This would necessitate an open reduction.

The femoral neck is osteotomised in situ following the pre-operative plan along the intertrochanteric line between the cervicotrochanter junction and the insertion point of the vastus lateralis. A long, stiff bladed oscillating saw (blade 11 cm long and 2.5 cm wide; offset tooth size 1 mm; screw supporting blade positioned medially) is used to make a single cut osteotomy. Because of leg pressure and the risk of collapse, this cut should be made carefully and preferably without stopping until completed (Fig. 5.7).

Adopting the position shown in Fig. 5.7 prevents an impingement occurring between the oscillating saw and retractors. A final cut with ostetomes is sometimes necessary to separate the femoral neck from the greater trochanter.

It is important to remember that too much traction on the leg can result in a wrong cut being made. Furthermore, excessive external rotation can result in too much removal of the posterior cortical bone of the femoral neck.

Cutting the femoral neck in situ avoids femoral fracture and damage to the tensor fascia lata. It also enables the optimal length of the neck to be precisely controlled. This is important since a longer than optimal femoral neck can lead to difficulties when reaming both the acetabulum and the femur, and it avoids inserting the stem into a varus position.

The femoral head extractor is inserted into the head of the femur and moved in a cranial-distal direction to tear adhesions with the capsule. This procedure usually enables the head of the femur to be easily removed from the acetabulum. If necessary, additional leverage can be provided by a Lambotte spoon inserted into the facies semilunaris of the acetabulum. It is rarely necessary to cut the head of the femur into pieces in order to extract

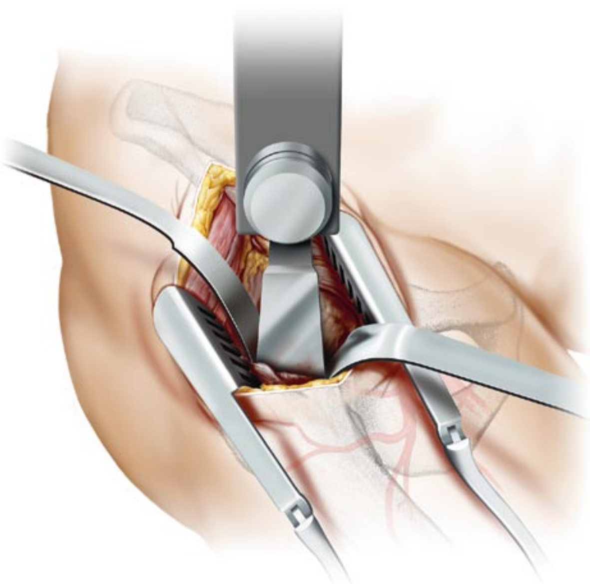

Fig 5.7 Single-cut osteotomy with the osscillating saw between the retractors

it. The length of the removed part of the femoral neck is measured in order to determine if the level of neck resection is appropriate in relation to the lesser trochanter.

The round ligament (ligamentum capitis femoris) attached to the head and the anterior insertion of the transverse ligament (ligamentum transversum acetabuli) are both incised. In the latter case, care is taken not to sever the neighbouring artery and obturatory nerve.

5.6.3 Preparation of the Acetabulum

Once the acetabulum has been exposed, an autostatic retractor (see Sect. 5.2) is positioned below the psoas line to give upward leverage and improved access for reaming. The anterior wall of the acetabulum is checked (using a finger). Where hip dysplasia is detected, it may be necessary to perform an augmentation graft. Osteophytes are not normally removed, in order to minimise the risk of developing heterotopic bone formation following THA.

The acetabulum is carefully reamed (both centrally and medially) using a Chana reamer (Fig. 5.8). Power reaming can be used, but the progress of reaming should be checked at regular intervals using an aggressive curette, and later by inserting a standard sized test cup into position. Manual reaming of the final reamer size is recommended to avoid over reaming of one acetabular wall. Overreaming (especially of the anterior wall) risks creating a lever effect between the Chana reamer and the incision. We advise reaming until the cancellous bone at the deep aspect of the acetabulum and bleeding subchondral bone of the semilunar surface of the acetabulum is observed.

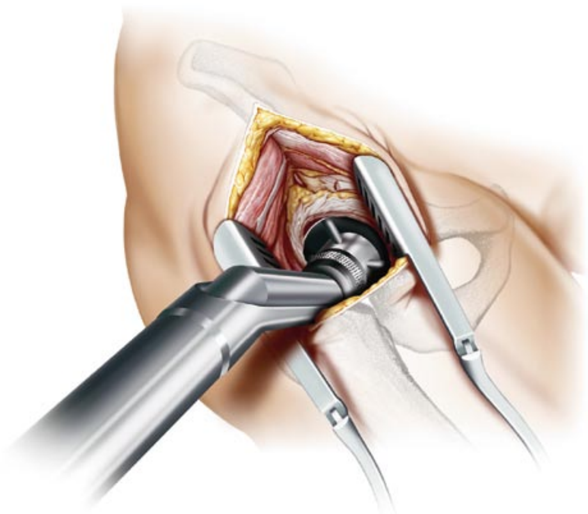

Fig 5.8 Reaming of the acetabular bone with a angled reame

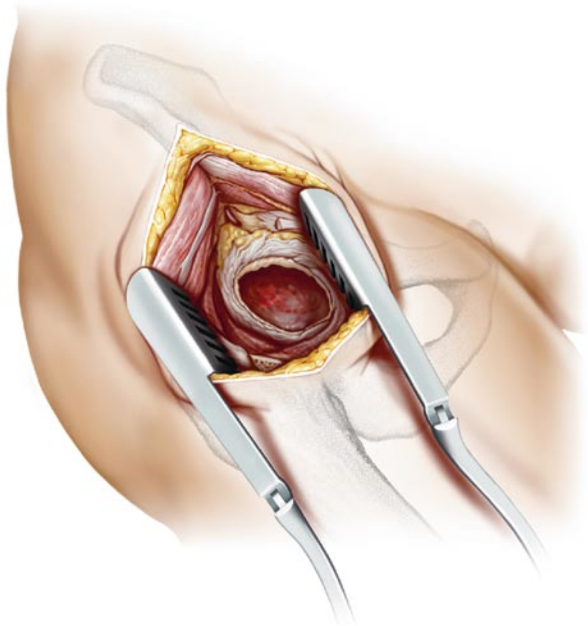

Fig 5.9 Exposition of the reamed cup

The Chana reamer and retractors serve to protect the surrounding soft tissues from damage during reaming (Fig. 5.9). Use of the Chana reamer is particularly necessary when preparing the acetabulum for THA in obese patients.

Once reaming is completed, the cup is inserted using a curved cup inserter. Care is taken not to position the cup in too much anteversion or too vertically. The cup is impacted into its final position using a special curved impactor and 1 kg hammer. The impactor is a long rod that allows a good transmission of force from the hammer to the cup. This ensures that the cup is firmly stabilised in the hip and avoids the necessity to use screws to obtain the required stability. Additional screws have been used in Lesur's experience in one single patient.

Instruments normally used for inserting the cup inlay by the conventional approach are not practical for the MIS approach due to the small size of the incision. Therefore, the surgeon needs to adopt a cranial position (seeing less but feeling more) and use the fingers covered with a sterile swab to insert the ceramic inlay. The procedure for inserting the inlay is typical for other MIS approaches used for THA.

5.6.4 Preparation of Femur

Preparation of the femur begins with a repositioning of the patient, during which full external rotation is applied to the leg (120° at the foot; 90° at the patella) (Fig. 5.10). Traction of the table is released and hyperextension is applied by moving the leg to the ground. Movement of the foot is necessary to avoid traction on the femoral nerve. To achieve this external rotation, it is first necessary to release the capsule from the anteromedial border of the neck to the lesser trochanter by electrocautery. During this procedure the vastus lateralis is protected by the electrocauterizing tool using forceps (Fig. 5.11). The capsule is released using the Lambotte retractor. Sometimes this requires exposure of the digital fossa of the greater trochanter.

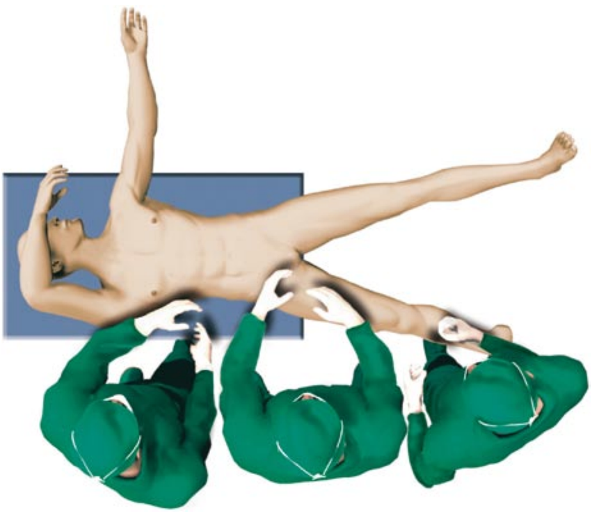

Fig 5.10 Exposure of the femur by hyperextension, moving the leg towards the ground

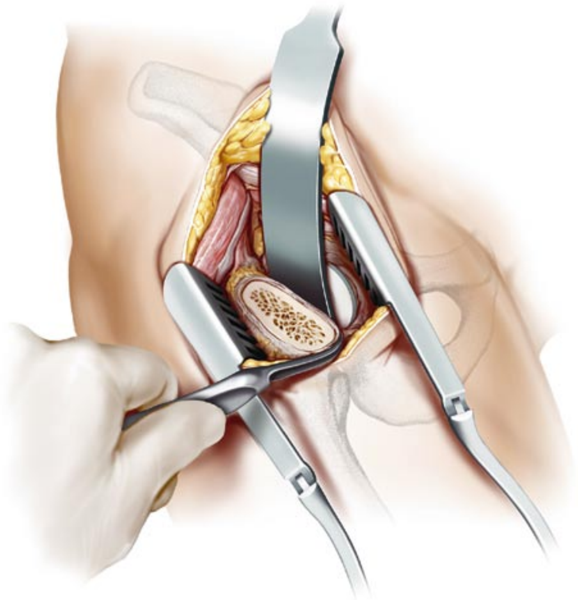

Fig 5.11 Release of the capsule using a Lambotte retractor

The femoral neck is exposed to enable broaching and insertion of the prosthetic stem. This involves a lateral manipulation of the femur using a Cobra retractor, and a check on the position of the lesser trochanter using the fingers. The autostatic retractors remain in the same position as before.

The femoral cavity is manually prepared using an anatomic rasp that is inserted into the medullary canal without the use of a hammer. Two types of anatomic rasps are available and are shaped to suit the curvature of either the right or left femur. The shape of the anatomic rasp eliminates the risk of false passage and breakage of cortical bone. The sound emitted from a suction device placed in the femoral cavity gives the surgeon an indication if femoral preparation has resulted in damage to the bone.

Progressively, larger rasps attached to a universal rasp handle are inserted into the femoral cavity until the correct depth has been reached. The universal rasp holder can be repositioned during each insertion/removal cycle in order to ensure that the force exerted on the rasp is in the correct plane (at 15–20° to the axis of the rasp) and not liable to fracture the femur (Fig. 5.12). The handle of the universal rasp holder can also be removed to avoid impingement with soft tissues. In such a case, the handle is replaced by the rasp and stem impactor.

The smallest anatomic rasp assumes a varus position that later becomes optimal with the insertion of progressively larger straight stem rasps. Optimal insertion of the final rasp (prior to the prosthetic stem) is defined by the pre-operative planning and could be indicated by a minimal gap between the rasp and the femoral calcar.

The stem is inserted into the femoral cavity using the rasp impactor previously described (Fig. 5.13). The lesser trochanter is used as a landmark for stem insertion. The stem is then gently hammered into final position, at which point a blow to the prosthesis neck emits a dull thud rather than a hollow sound. Accurate positioning of the stem is usually easier for

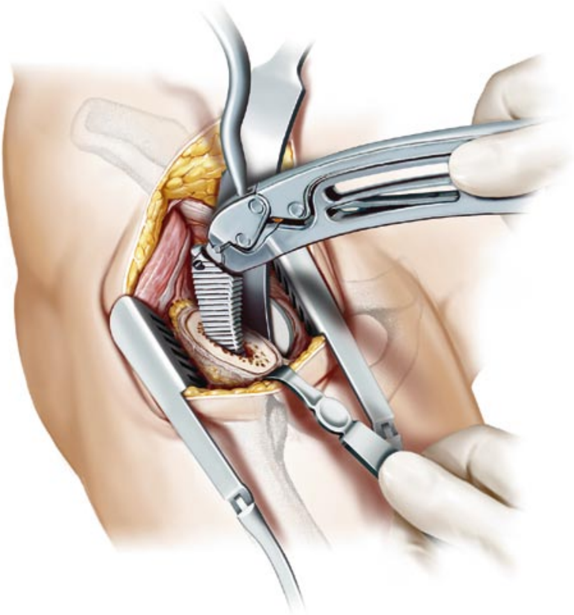

Fig 5.12 Demonstration of an universal rasp holder and broaching of the femur

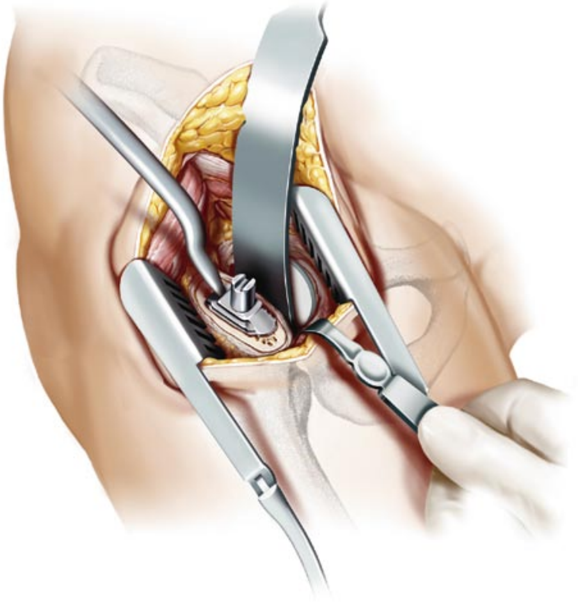

Fig 5.13 Stem impacted into the femur

cemented implants compared with uncemented implants. An uncemented stem implanted with a margin of error up to 5 mm can be compensated for by selecting an appropriately sized modular head with a shortened or lengthened neck.

The “scrubbed” assistant attending the surgeon assumes a fixed position, and secures the position of the retractor with one hand, while checking the position of the patella with the other hand. The assistant is only allowed to change position when the prosthesis stem is in place. This is to ensure that the femur remains in the same position during the operation.

5.6.5 Reduction

Reduction is achieved by raising the leg under strong traction and then applying internal rotation while the foot remains fixed on the extension table. The leg is rotated from the 90° to the 0° position, and traction is released to allow the femoral head to enter the cup inlay. Tissue debris is removed by thoroughly rinsing the cavity with saline or Ringer solution.

5.6.6 Closure

An aspiration drain is placed in the cavity at the depth of the superficial muscles. The superficial aponeurosis of the tensor fascia lata muscle is sutured, with care taken not to damage the lateral femoral cutaneous nerve. The subcutaneous fat is then sutured, and staples or normal (non-resorbable) stitches are used to close the skin. The average time taken to perform this surgical procedure for an experienced surgeon from incision to closure is approximately 1 h, and the patient is able to walk on the same day only hours after the operation. The aspiration drain is removed and the dressing is changed according to local procedures.

5.7 Post-Surgical Care and Rehabilitation

5.7.1 Immediate Post-Surgical Care

When the patient is carefully transferred from the operating table to a recovery bed, the affected leg is preferably given an internal rotation to prevent anterior dislocation of the hip and the patient is positioned in the beach chair position. A pillow is placed under the knee in order to bend the leg and flex the hip. This position reduces tension on the post-operative scar, and lowers the risk of anterior dislocation when the patient is sleeping and the hip musculature is relaxed.

Anterior dislocation occurs rarely in patients as long as the guidelines are adhered to: sleeping during a 6 week period with a slightly flexed hip. The hip should be fully flexed on the day of surgery. Indeed, sharp twisting movements of any sort and attempts to run during the rehabilitation period should be avoided.

Low-dose heparin is administered 6 h after surgery, and continued for the next 3 weeks in order to prevent post-operative DVT.

5.7.2 Physiotherapy

Physiotherapy is normally not necessary. Less active patients should engage in mild exercise (walking) to reduce the risk of DVT. The patient is also encouraged to continue wearing the compression socks as a preventive measure against DVT.

5.8 Complications

5.8.1 Pre- and Intra-Operative Events

There are three main intra-operative complications that are *specific to the conventional as well as the MIS anterior approach*. First, there is a risk of femoral fracture if the hip is dislocated before cutting the femoral neck. Second, the use of non-adapted instruments (e.g. straight starter rasps) to open the femur can increase the risk of perforation, cause breakage of the greater trochanter or cause spiral femoral fractures (due to excessive removal of anterior cortical bone). Third, the use of a straight rod to insert the acetabular cup can lead to malpositioning of the implant (i.e. too vertically and/or too anteverted).

5.8.2 Post-Operative Events

There are two main post-operative complications that are specific to MIS by the anterior approach. First, anterior dislocation of the hip is possible if patients do not adhere to guidelines during the rehabilitation period (Sect. 7.1). When this occurs, re-operation is unnecessary as closed reduction can be performed under general anaesthesia. Second, a trochanteric fracture can develop from a powerful contraction of the gluteus or piriformis muscles in very active patients. The trochanteric muscles are often weaker than the gluteus muscle after THA, and this increases the risk of fracture during the post-operative period.

Infections occur rarely with this approach and are mostly superficial. The low incidence of infection may be related to the distance between incision and perineal area of the patient. During surgery we rinse the surgical field thoroughly every 10 min and at the same time change gloves.

5.9 Personal Experience, Outcome and Success Rate

During the last 17 years, Lesur has performed over 1000 THA using only the anterior approach (350 of these were done by the anterior MIS approach). The majority of these THA had a successful outcome, with no severe complications nor need for extensive revision surgery. Indeed, patients with conditions normally considered as general contraindications for THA (including dysplasia, coxa vara, coxa valga, and acetabular revision) had good outcomes using this approach.

The positioning of the stem is well controlled using the universal MIS rasp handle, which became available in 1993. The orientation of the cup is easily managed using the MIS shell impactor.

Revisions were carried out in six cases after MIS anterior approach. These revisions were for two fractures of the greater trochanter, one calcar fracture after fall from height, two cases of non-osteointegration of the femoral implant, and one case of non-osteointegration of acetabular implant. Four cases developed post-operative infections, which were superficial and did not involve the hip joint. No cases of clinical post-operative DVT occurred in the last 100 patients using the MIS anterior approach without retractors placed in the pelvis.

MIS by the anterior approach is a technique that can be performed by any surgeon with reasonably good dissection skills. A surgeon having performed a minimum of 50 THA using this technique could consider himself proficient with the anterior approach.

With the MIS anterior approach one has to respect, similar to intramedullary nailing, the following steps:

- Patient installation on the table.
- Following of the anatomic landmarks.
- Sufficient removal of the anterior capsule and the femoral neck.
- Usage of long and less aggressive instruments as well as the instruments specifically developed for this approach.
- Use of an implant combination that reduces factors, which can limit the longevity of the implants (such as cementless prosthesis with ceramic/ceramic articulation).

With this technique of cementless stem and cup implantation, we were able to develop an advantageous and reproducible surgical technique, without major peri- or post-operative risks or complications.

Patient satisfaction with the anterior approach is high due to their rapid rehabilitation following surgery. This has a significant impact on reducing health costs.

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The Anterolateral Approach with the Patient in Lateral Position[1]

6

Werner Siebert

6.1 Introduction

Minimally invasive surgery (MIS) by the anterolateral approach is described in this chapter. This method is a muscle preserving modification of the conventional Watson-Jones approach [1]. A major problem with the conventional approach was that it involved detachment of abductors (gluteus minimus and often gluteus medius) from the greater trochanter. Although abductor detachment gave good exposure of the hip joint for THA, it often resulted in dislocations and permanent postoperative limping [2–4].

The Watson-Jones approach [1] was modified over the years, as surgeons found ways to minimize muscle trauma and limping caused by detachment of abductors. They also succeeded in making the conventional incision shorter and less invasive.

Heinz Röttinger is a pioneer of the MIS anterolateral approach, and one of the first surgeons to recognize the importance of preserving abductor muscle attachments intact [5]. He developed an approach to the hip by an intermuscular interval which is anterior to the abductors and posterior to the tensor fascia lata [5]. Röttinger showed that abductor function is maintained after THA, and that posterior dislocation is unlikely, since the posterior capsule and muscle function is retained.

The author of this chapter, Prof. W. Siebert, D-Kassel, has performed more than 500 THA using a MIS anterolateral approach based on Röttinger [5]. Patient satisfaction with this approach is good. No cases of postoperative dislocation or limping have been found.

[1]Please make yourself familiar with the handling of the instruments, the product-related surgical technique and the warnings, the safety notes as well as the recommendations of the instruction leaflet before using an implant manufactured by Mathys Ltd Bettlach. Make use of the Mathys user training and proceed according to the recommended surgical technique.

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Patients can expect to walk in 3–4 days after operation. After this approach, patients have less pain, need less postoperative medication, and have a faster rehabilitation than after conventional surgery.

6.2 Patient Selection

6.2.1 Examination

Preoperative examination of the patient is conducted as usual. Full sized plain radiographs of the pelvic region are made in the anteroposterior and lateral planes. Long anteroposterior radiographs are preferred for measuring stem thickness and for determining the best fitting stem.

The template for the acetabular cup is orientated according to Köhlers tear drop and the bottom of the cup. The template for the femoral shaft is orientated according to the tip of the greater trochanter.

The centre of the mechanical axis of both, the cup and the femoral neck are marked on the X-ray. This allows optimal neck length of the modular head to be determined, and aids the decision to use either a lateralized shaft or a standard shaft for the reconstruction of the patient's off-set.

In addition, the X-ray template allows the gap between the resection plane of the lesser trochanter and medial edge of the femoral neck of the implant to be measured.

These orientation distances can be checked during the implantation of the prosthesis.

6.2.2 Indications

The MIS anterolateral approach is suitable for all patients (active or sessile) of any age.

Restricted visibility is a challenge while performing MIS especially on overweight or muscular patients. However, high BMI is not a problem for the MIS anterolateral approach because patients are in a lateral position during surgery. The most obese patient operated on by the author had a BMI of around 66.3 (210 kg, 1.78 m, male).

The MIS anterolateral approach also permits revision surgery. Stem revisions in patients with Paprosky grades 1 and 2A femoral bone deficiencies [6] are possible using this approach. So also are acetabular revisions involving the exchange of small cups. Major revisions requiring a larger incision are not recommended using this MIS approach.

6.2.3 Contraindications

Major revision surgery is the most important contraindication for the MIS anterolateral approach.

Other contraindications for this approach are the same as those for conventional THR approaches.

6.3 Advantages

Compared with conventional surgery, there is no need to detach muscles from bone when using the MIS anterolateral approach. This approach preserves pelvic and femoral muscle attachments, especially all gluteal muscles of the hip.

Sometimes, it is necessary to gently undermine the tendon of the gluteus minimus. This improves access when inserting a more anatomical stem. Surgeons learning this technique are recommended to use a femoral stem with a smaller curved shoulder which is easier to insert. No injuries to the femoral or sciatic nerves occurred during surgeries performed by the author. In theory, any procedure involving dislocation/relocation of the hip can stress the sciatic nerve and cause temporary palsy of the peroneal branch (0.4% of cases). However, there is a risk of serious damage if hooks are not properly positioned below ventral muscles or on the dorsal acetabular rim.

The anterolateral approach allows very good positioning of the acetabular prosthesis, control of leg length, and placement of any type of cemented or uncemented stems. The distance from lesser trochanter to the assumed hip centre is easily measured and provides accurate control of leg length.

Cemented stems are well fixed with third generation [7] and fourth generation [8] cementing techniques.

Bleeding is largely due to muscle trauma. To reduce blood losses, the author uses a blood retransfusion system intraoperatively, and up to 10 h postoperatively. With a retransfusion system, only 300–400 mL of blood is lost during MIS compared with 800 mL during conventional hip surgery. Patients are less likely to need a blood transfusion. This has the advantage of minimizing the risk of patients contracting infectious diseases from contaminated blood. In addition, hospital costs are reduced.

After MIS surgery, patients feel generally much stronger, because they have less pain, require fewer painkillers, and rehabilitate faster, than after conventional surgery. These patients show almost no limping and some are even able to walk without crutches immediately after surgery. The following day, they are encouraged to walk and allowed to put full weight on the operated hip. On average, a patient can expect to walk without crutches within 2 weeks after THA by the MIS anterolateral approach. There is also no risk of posterior dislocation or gluteus weakness using the MIS anterolateral approach [5, 9].

According to the author, patients can expect to lead an active lifestyle after the surgery. The extent of activity largely depends on the type of implant and condition of their hip muscles before operation.

Postoperative infections are very rare after hip arthroplasty performed by conventional and minimally invasive techniques. So far, the author encountered no postoperative infections in his 500 cases with the MIS anterolateral approach.

In general, a hospital stay of 10 days is planned for all hip patients. However, many patients feel fit enough to be discharged after 5–7 days. Discharged patients have the option to attend an outpatient rehabilitation clinic. Postoperative recovery time to walk unaided depends on age and health status of the patient. Recovery time ranges from 5–6 days for a young patient, to 6–8 weeks for very old and handicapped patients.

The cosmetic benefit of MIS is a smaller incision scar compared with conventional surgery.

6.4 Disadvantages

The main disadvantage with the MIS anterolateral approach is the risk of fracturing the greater trochanter. This can happen during the insertion of a straight femoral stem. If so, the best way to reattach a fractured greater trochanter is to use a hook plate along with cerclages.

6.5 Patient Positioning/OP Field

6.5.1 Patient Positioning

All patients receive low-molecular-weight heparin 1 day preoperatively to reduce the risk of deep vein thrombosis. Special compression socks are not necessary during surgery but may be worn postoperatively.

The patient is wrapped in a small vacuum mattress extending from pelvis to shoulder. Then the patient is positioned laterally on an operating table. The torso of the patient is held securely between two support blocks at the front and back of the table. A leg holder is not required. Good stability is achieved by withdrawing air from the mattress and applying pressure from support blocks, on the symphysis from ventral and on the sacrum from dorsal. The author uses a common operating table. One leg part of the table distal to the pelvis can be removed during surgery. This allows the operated leg to be optimally positioned.

Spinal anesthesia is used unless the patient requests otherwise.

The leg is draped with a paper cover and the hip with a transparent incise drape which allows free movement of the operated leg. A foot bag is attached to the contralateral leg, which ensures that the operated leg remains sterile during surgery. At the beginning, the leg remains in a slight abduction for muscle relaxation and to avoid soft-tissue damage induced by hooks. The slight additional external rotation facilitates the preparation of the acetabulum.

The surgeon stands in front of the patient and is attended by two assistants located behind the patient. One “scrubbed” assistant holds the retractors while the other assistant positions the operated leg. After insertion of the cup, the lower leg is placed in an extended, externally rotated adducted position. Handling the leg with care is of great importance to reduce and adapt muscle tension for better sight of the situs and facilitating surgery according to the progress of the operation.

6.5.2
Surgical Instrumentation

Generally, standard instruments can be used. However, it is helpful to have a few specific surgical instruments for the MIS anterolateral approach. Small sharp retractors are used during superficial dissection. Also, two curved Hohmann-retractors No. 7 are helpful to expose the femoral neck.

An oscillatory saw with a long stiff narrow blade (18 mm) is necessary to osteotomize the femoral neck. Normally, the femoral head and neck can be removed in two pieces with strong bone tweezers or a Lion clamp. When the adhesion between head and acetabulum cannot be broken with a Lion clamp, a femoral head extractor can be used instead. A large femoral head can be easily removed after cutting it into two pieces with the saw.

The author prefers a straight instrument to ream the acetabulum – even in obese patients. Reaming with a curved instrument is also possible, but the risk of cutting through the superior rim of acetabular bone is much higher.

Once the hip cup has been properly positioned, final impaction is done with a curved impactor. A curved impactor provides better transmission of force and has a low risk of impinging on wound edges. The cup inlay is inserted by hand and given two or three blows with a hammer to secure it.

The choice of instrument for reaming the femur depends on the type of stem to be implanted. An anatomic reamer is normally used for a curved stem and a straight reamer for a straight stem. The author prefers a straight reamer and straight stems.

During broaching, a skin protection sleeve protects the skin from trauma. The sleeve can be found in the intermedullary nailing kit.

Instruments for implanting a specific brand of hip prosthesis are normally product specific and are supplied by the manufacturer of the implants.

6.5.3
Hip Prosthesis

There are no limitations on the type of prosthesis which can be implanted using the MIS anterolateral approach. The choice of prosthesis depends mainly on the indication and preference of the surgeon. For cases with severe osteoporosis, a cemented stem is recommended to avoid fracturing the femur.

The author prefers straight femoral stems with a flattened shoulder for uncemented insertion, and Charnley stems for cemented insertion. For cups, he uses press-fit systems.

6.6
Surgical Technique

6.6.1
Incision and Approach

Whilst the patient lies in a lateral position, the iliac crest is palpated to locate the anterior superior iliac spine. A guideline for the skin incision is drawn from the anterior tubercule of the greater trochanter to the anterior superior iliac spine. The skin incision begins at the anterior tubercule and normally extends 7–9 cm towards the iliac spine. It is important that the first 2 cm of this incision lies over the trochanter. An incision of up to 10 cm is sometimes necessary for an obese patient. The superior gluteal nerve lies posterior to the incision and is protected from damage by the gluteal muscles. Only procedures involving incision of these muscles risk damaging the nerve (Fig. 6.1)

Subcutaneous fat is incised and retracted in line with the skin incision. Two small sharp retractors are recommended. The underlying tensor fascia lata and gluteal muscles (minimus and medius) are palpated to locate the intermuscular interval between them. Beginning at the femoral insertion side, the first incision in the fascia lata is made close to the greater trochanter. This exposes a small fat pad which acts as a guide to the intermuscular interval. A finger is inserted into this interval and a blunt dissection of muscles is made down to the joint capsule. The gluteal muscles are retracted with the first Hohmann retractor placed inferior to the femoral neck and overlying the joint capsule. Owing to anatomical variations, it is sometimes necessary to undermine the tendon of the gluteus minimus with an electrocautery knife. This avoids having to cut the gluteal muscles and improves exposure of the joint capsule (Fig. 6.2).

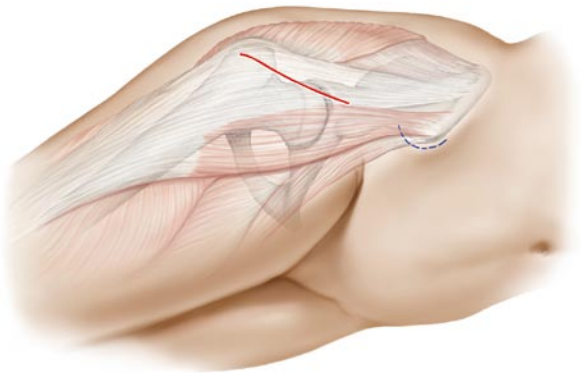

Fig 6.1 Skin incision of the MIS anterolateral approach in relation to bony landmarks

Fig 6.2 Incision of the fascia in line with the skin incision

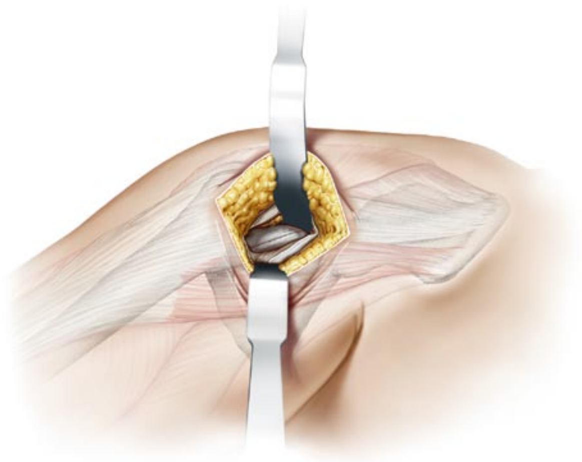

Fig 6.3 Hohmann retractors demonstrating and protecting the femoral neck before osteotomy

Dissection is continued by electrocautery until the lesser trochanter can be palpated. A second Hohmann retractor is then placed inferior to the calcar to fully expose the joint capsule (Fig. 6.3).

6.6.2 Preparation of the Femoral Neck

An anterior capsulectomy exposes the femoral neck. A U-shaped incision is made ventrally in the capsule. The proximal margin of this incision lies at the anterior rim of the acetabulum, while the distal margin lies along the femoral neck. The lateral margin of this incision is at the insertion of the capsule along the intertrochanteric line.

The anterior capsule is removed as close as possible to the vastus lateralis muscle to expose the femoral neck. The author prefers to resect (rather than resuture) the anterior capsule for a number of reasons. Fewer postoperative problems (e.g., pain and swelling) occur when the capsule is resected. The operated hip has a greater range of motion. In addition, the author encountered no dislocations in any of his patients after resecting the capsule [10–12].

Two osteotomies are performed in situ on the femoral head and neck. The operated leg is put in a slight external rotation position and the hip, in a 20° abduction.

The first osteotomy is made at the junction of the femoral head and neck with a stiff bladed oscillating saw. A chisel is inserted to make sure that the cut is complete. A Cobb rasp raises the femoral neck from the capsule and allows repositioning of the two Hohmann retractors. Both retractors protect underlying tissues during osteotomies. Prior to the first cut, these retractors are positioned in the capsule and close to the femoral head.

The second osteotomy is performed on the lateral part of the femoral neck, near the greater trochanter and on the calcar according to preoperative planning. The operated leg is put in external rotation and placed in the sterile bag. This leg position optimizes

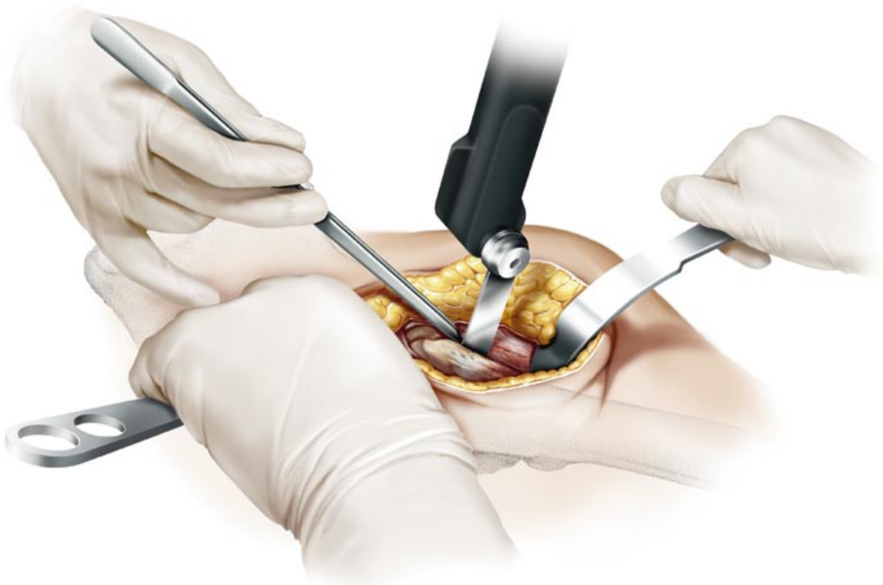

Fig 6.4 femoral osteotomy in the minimal incision technique

exposure of the femoral neck. The Hohmann retractors are repositioned anterior to the greater trochanter and under the calcar. The hip osteotomy is orientated at the piriformis fossa which is the deepest point of the lateral femoral neck.

The distance from lesser trochanter to the proposed cut can be checked with a ruler. If for any reason the femoral neck is cut too long at this stage, it can be recut when the femur is prepared for stem insertion.

The femoral head and neck fragments are normally removed with bone tweezers or a Lion clamp and for difficult cases with the femoral head extractor (Fig. 6.4).

6.6.3 Preparation of the Acetabulum

Once the femoral head has been removed, both Hohmann retractors are repositioned to expose the acetabulum. One retractor displaces the femur posteriorly, while the other retracts the medial and ventral musculature. An additional retractor is sometimes needed for obese patients (Hohmann type), or for those having strong musculature (Hohmann or wide Langenbeck type). The operated leg is kept externally rotated and extended during acetabular preparation.

The labrum and any capsule or soft tissue, which may obstruct insertion of the cup are excised. Some cartilage may also need to be removed. Hemostasis of the wound is achieved with electrocautery.

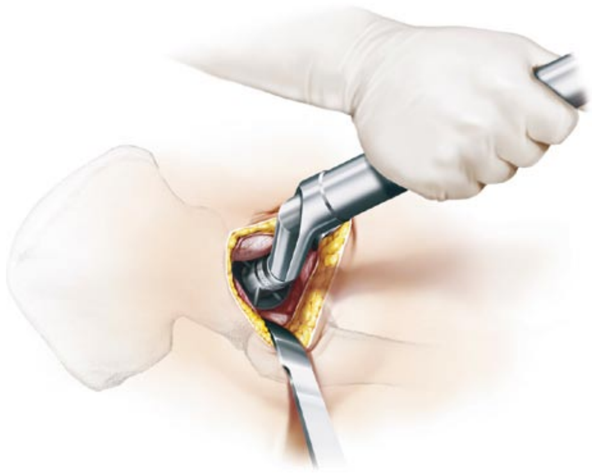

Fig 6.5 reaming the cup with the curved minimal invasive reamer

The acetabulum is carefully prepared with a straight reamer. Fitting the reamer with increasing head sizes gives the surgeon better control over the final shape of the acetabulum. Reaming continues until the bone is bleeding and the acetabulum is optimally prepared for inserting the cup. According to the author, the risk of over-reaming the superior acetabular wall is increased with a curved reamer.

Bone grafting may be necessary if cysts are encountered. Typically, the acetabulum is underreamed by 2 mm for optimal fitting of the cup. The press-fit cup is inserted in the acetabulum with an implant specific MIS cup impactor using the alignment guide (20° anteversion; 45° inclination). Screws are normally unnecessary to secure the cup.

After the cup has been properly positioned, the final impaction is done with a curved impactor. The cup inlay is inserted by hand and given two or three blows with a hammer to secure it. A sterile sponge may be temporarily inserted into the cup to protect it from debris during reaming of the femur. Of course, monoblock cups like the RM Pressfit are implanted in one piece with a curved impactor.

Osteophytes are removed after insertion of the cup (Fig. 6.5).

6.6.4 Preparation of Femur

The operated leg is repositioned and given as much hyper extension as possible (90° external rotation; 30° adduction). The lower leg is placed in the sterile bag. A Hohmann retractor is placed around the greater trochanter and a Cobra retractor, under the calcar region. The femur is then levered upwards to improve exposure of the cut femoral neck. The distance from lesser trochanter to calcar can be checked with a ruler and recut if necessary (Fig. 6.6).

The femoral canal is manually opened with a small curved spoon. A box chisel is used to open the proximal femur. This is done carefully to avoid possible mal positioning of the

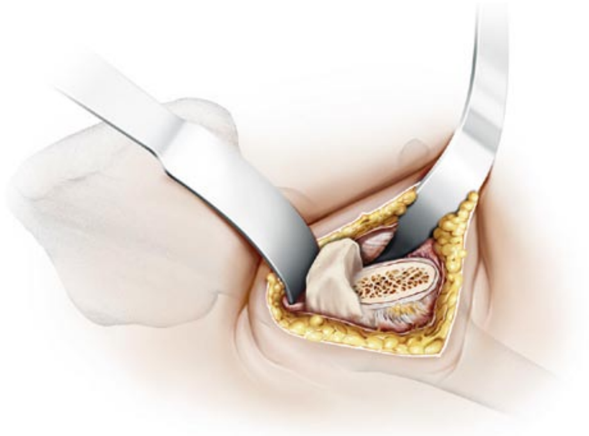

Fig 6.6 exposing the proximal femur with 2 Hohmann retractors

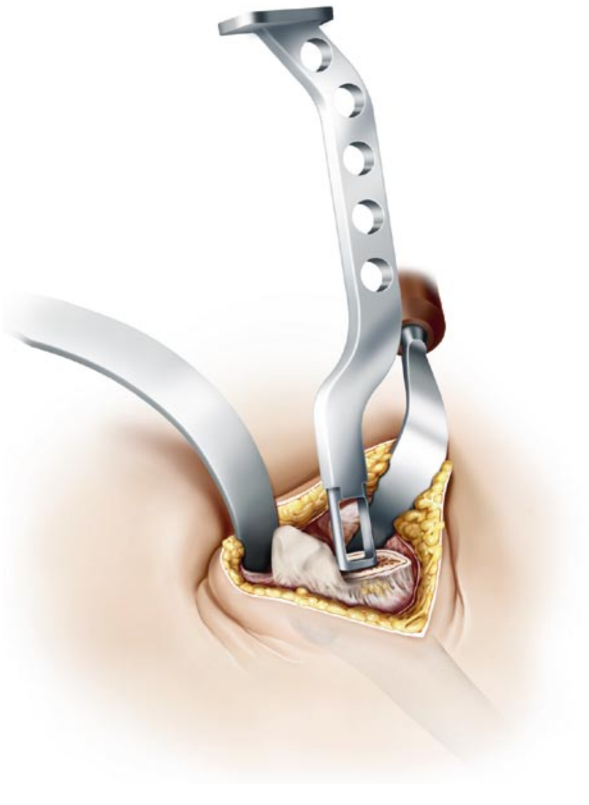

Fig 6.7 use of a box chisel to open the proximal femur

femoral stem. The canal is then widened with progressively larger reamers. Straight reamers prepare the canal for insertion of a straight stem (Fig. 6.7).

Broaching is performed with the appropriate angled hand pieces for right or left side. A sleeve protects the skin from being scratched during broaching.

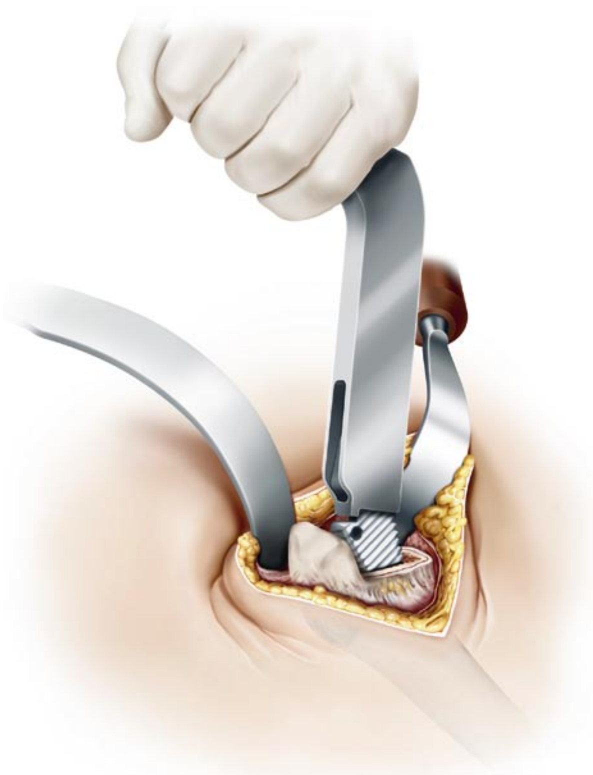

Fig 6.8 broaching the proximal femur with a curved handle

The final broach or rasp functions as a trial stem. In this position, trial head and neck components are placed on the stem. Then the operated leg is removed from the sterile bag and internally rotated to reduce the hip and to check the range of motion and leg length (Fig. 6.8).

Removal of the trial stem is done after externally rotating the operated leg and dislocating the hip. The operated leg is placed in the sterile bag. The final prosthesis is inserted with conventional surgical instruments and techniques (Fig. 6.9).

One mistake frequently made by inexperienced surgeons is to inadequately ream the femur. This can lead to varus positioning of the stem and must be corrected by rereaming the femur (Fig. 6.10).

6.6.5 Reduction

An acetabular head component is securely positioned on the femoral stem by gently tapping with a hammer. We do not use a hammer to insert a ceramic head. Protective coverings are removed from the acetabulum and the operated leg is rotated to achieve final reduction.

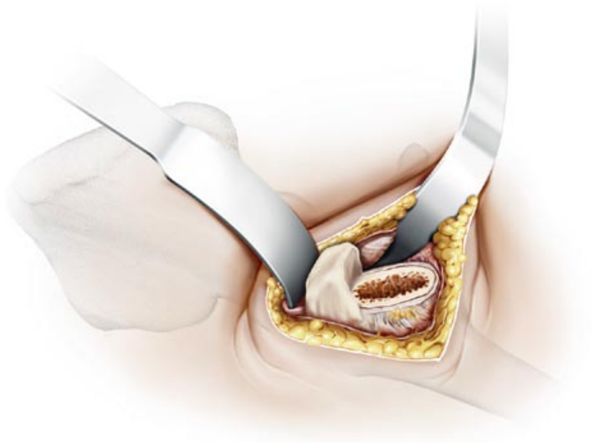

Fig 6.9 proximal femur exposed before implantation of the stem

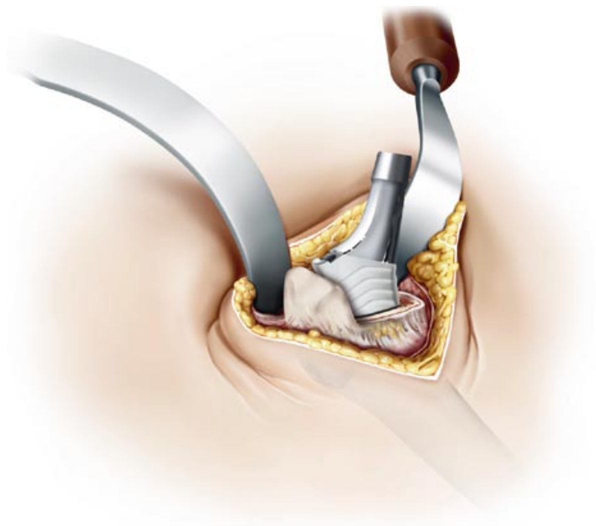

Fig 6.10 implantation of a cementless stem in minimal invasive technique

The cup cavity is rinsed 3–4 times with saline solution to remove tissue debris. Two Langenbeck retractors are placed in order to improve visibility of the implant. The implant is palpated to recheck that it is well fitted and not loose.

Stability of the implant is tested by variously positioning the operated leg while the patient is on the table. A radiograph (Judet view) is taken to check fitting of the acetabular cup and stem. Leg length is checked from knee position when both legs are adjacent on the table.

6.6.6 Closure

A deep aspiration drain is placed in the cavity for 24–36 h depending on the extent of fluid loss. The drain is connected to a blood retransfusion system for the first 10 h and thereafter to a bottle.

The tensor fascia lata, subcutaneous tissue, and skin are all sutured. For cosmetic reasons, the skin can be sutured with intracutaneous stitches and paper tapes.

The average operating time with the MIS anterolateral approach is 45–60 min for an experienced surgeon.

6.7 Postsurgical Care and Rehabilitation

6.7.1 Immediate Post Surgical Care

The patient is transferred from the operating table to the recovery bed.

No special precautions are necessary to prevent hip dislocation.

Normally full range of motion with the operated leg is permitted.

Patients are allowed to pivot full body weight on the operated leg. However, crossing the legs is not advised. All patients receive low weight heparin once per day and sometimes wear compression stockings to reduce their risk of developing DVT.

Patients with a high risk of DVT can be treated postoperatively with an intermittent pneumatic compression device.

6.7.2 Physiotherapy

Physiotherapy is a necessary part of the rehabilitation process. Counseling is also important to build up confidence in those patients who are afraid to walk on the operated leg. All patients are supplied with an illustrated brochure which provides information on what they can/cannot do during the rehabilitation period.

6.8 Complications

6.8.1 Pre-and Intraoperative Events

Three main intraoperative complications can occur. Firstly, the gluteal muscles may be damaged during dissection. This is more likely when the intermuscular interval is not properly identified. Secondly, the superior rim of the acetabulum can be damaged by over-reaming with a curved reamer. Thirdly, the greater trochanter can be fractured by not using the appropriate instruments to ream the femur or by malpositioning of a Hohmann retractor.

A femur fracture can also occur, but is not specific to this approach.

6.8.2 Postoperative Events

Unrecognized fissuring of the greater trochanter can lead to a fracture of the greater trochanter, which is the main postoperative complication specific to the MIS anterolateral approach. A CT scan of the femur, after insertion of the stem, can show fine strain lines. These strain lines represent areas of weaker bone and can cause a fracture of the greater trochanter or the proximal femur. It is important to note that a CT scan is not done routinely but only for scientific purposes.

6.9 Personal Experience, Outcome and Success Rate

Over the past 25 years, the author has performed more than 3,000 THAs by anterolateral, lateral, and posterior approaches.

The author operated on more then 500 cases with the MIS anterolateral approach. High success rates and patient satisfaction were achieved. Indeed, patients for THA request this technique and are prepared to travel long distances for surgery.

Revision surgery was needed for only one patient.

The patient (male, early 50s, active) had a THA with two screws inserted to secure the cup. Full weight bearing was allowed after surgery and the patient was walking without crutches (and even running) at 5 days post-op. The cup inserted may have been too small and later settled deeper in the hip. The patient reported a “pumping” sensation in his hip joint. This suggested that some loosening had occurred and was corrected by revision with a larger cup.

According to the author, the MIS anterolateral approach leads to approximately 33–50% shorter hospitalization and rehabilitation periods compared to conventional surgery. This offers substantial cost savings estimated at 33–40% [13].

Any surgeon wishing to learn the MIS anterolateral approach needs a good theoretical background along with cadaver laboratory and surgeon-to-surgeon training (mandatory). The author recommends starting with a larger incision which can be made smaller as experience is gained.

A surgeon can consider himself or herself proficient with the MIS anterolateral approach after having performed a minimum of 15 THAs with this technique.

First interventions need to be accompanied by an experienced surgeon in a surgeon-to-surgeon training. According to the author’s experience, MIS anterolateral surgery is challenging but much easier to apply than a two-incision approach.

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The Anterolateral Approach with the Patient in Supine Position[1]

7

Joachim Pfeil

7.1 Introduction

Minimally invasive surgery (MIS) by the anterolateral approach with the patient in supine position is described in this chapter. The approach is a muscle preserving modification of the conventional Watson-Jones approach [1].

The main problem with the conventional approach is that it involves detaching abductors (gluteus minimus and gluteus medius) from the greater trochanter. Abductor detachment can lead to dislocations and permanent post-operative limping [2–4].

The Watson-Jones approach [1] was modified by surgeons who found ways to minimise muscle trauma and consequent limping caused by detachment of abductors. These surgeons also began making the conventional incision shorter and less invasive.

Heinz Röttinger was an important pioneer of the MIS anterolateral approach. He was one of the first surgeons to recognise the importance of preserving the abductor muscle attachments intact [5]. Röttinger developed an approach to the hip by an intermuscular interval, which is anterior to the abductors and posterior to the tensor fascia lata [5]. He showed that abductor function is maintained after total hip arthroplasty. Furthermore, posterior dislocation is unlikely since the posterior capsule and muscle function is retained.

Modifications to the Röttinger approach [5] were made by Graf [6], Roth [7], and the author of this chapter. Differences between the author's approach and the Röttinger

[1]Please make yourself familiar with the handling of the instruments, the product-related surgical technique and the warnings, the safety notes, as well as the recommendations of the instruction leaflet before using an implant manufactured by Mathys Ltd Bettlach. Make use of the Mathys user training and proceed according to the recommended surgical technique.

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approach are patient positioning and skin incision. Röttinger placed his patient in a lateral decubitus position whereas the author prefers the supine position. Both methods expose the capsule using a similar intermuscular route.

The author of this chapter, Prof. J. Pfeil, D-Wiesbaden, has performed 500 total hip arthroplasties using a MIS anterolateral approach with the patient in supine position.

According to the author, no cases of post-operative dislocation or limping were found. Patients can expect to walk on the day after surgery. In addition, they have less pain and a faster rehabilitation than after conventional surgery.

7.2 Patient Selection

7.2.1 Examination

Pre-operative examination of the patient is conducted as usual. The patient's medical history is reviewed for any previous evidence of leg length discrepancy.

The range of motion of both hips is measured using a standard neutral method. The extent of internal rotation, external rotation, flexion, extension, abduction, and adduction of the hip to be operated on is measured and compared with the other hip.

A digital X-ray procedure is used for pre-operative planning. The leg length of the patient is checked with reference to the position of the lesser trochanter using this procedure. If leg length discrepancy is detected, it is important to establish if the discrepancy is due to a pre-existing condition or due to functional problems (worsening of the arthrosis for which hip replacement is indicated). Leg length discrepancy due to a pre-existing condition is corrected for during pre-operative planning.

Patients with severe arthrosis often develop functional leg length discrepancy due to an obliquely contracted pelvis. Functional leg length discrepancy is resolved by hip replacement surgery and should not be corrected for during pre-operative planning.

Sometimes it is not possible to use the leg to be operated on for pre-operative planning, e.g. when severe femoral head necrosis is diagnosed. In such cases, the author uses the contralateral leg for pre-operative planning with respect to leg length and offset. This is possible because the anatomy below the femoral neck is normally the same for both legs.

7.2.2 Indications

The MIS anterolateral approach is suitable for patients of all ages. In case of some bone tumours, the high variability in their size and location presents a particular challenge for the MIS anterolateral approach. The approach is suitable if tumours are small and located in the head or neck region of the femur. A more extensible surgical approach is necessary when the entire proximal femur is affected by a bone tumour, or when bone tumours occur below the trochanteric region.

Restricted visibility in the acetabular region can be a challenge while performing the MIS anterolateral approach on overweight patients. MIS surgery takes longer for an overweight patient. On an average, MIS surgery takes 45 min for a patient whose BMI is within normal range, and 60 min for a patient with high BMI. Nevertheless, high BMI is not considered a contraindication for this approach.

The MIS anterolateral approach also permits minor revision surgery. Defects in the acetabulum can be corrected using this approach.

7.2.3 Contraindications

Major revision surgery is the most important contraindication for the MIS anterolateral approach with the patient in supine position.

The MIS approach is not suitable for femoral stem revision when there is severe thinning of the cortex of the proximal femur. This type of revision is made with a long cementless stem that achieves fixation in the diaphyseal region of the femur. A trans-femoral approach requiring a larger incision is preferred for inserting this revision stem.

Again, the MIS approach is not suitable for femoral stem revision for bone metastases below the trochanter.

Other contraindications for this approach are the same as those for conventional THR approaches. Conditions which are not contraindications for this approach are congenital dysplastic hips (CDH), procedures requiring additional femoral osteotomy, patients with previous lumbar fusion and previous ipsilateral colostomy.

7.3 Advantages

Compared with conventional surgery, the MIS anterolateral approach with the patient in supine position has several advantages.

A standard operating table with two independent leg supports is used for the approach. The approach allows quick and easy positioning of the patient on the operating table. Anaesthetists can easily perform an emergency intubation on the patient.

It is not necessary to detach muscles from bone. The approach preserves pelvic and femoral muscle attachments, particularly the gluteal muscles of the hip.

Femoral and sciatic nerves remained uninjured during surgeries performed by the author. Two precautions are taken to avoid damaging these nerves. Firstly, the knee of the operated leg is flexed by 20° during the preparation of the acetabulum. A knee roll (20 cm diameter) is placed below the knee joint to support the leg in this position. This ensures that structures on the ventral side, including the femoral nerve, are not stressed. Secondly, the MIS approach allows good exposure of the acetabular capsule. Only small retractors are needed during surgery on the acetabulum. The use of small retractors further minimises the risk of damaging nerves.

The MIS anterolateral approach allows good positioning of the acetabular prosthesis, control of leg length, and placement of cemented or uncemented stems. As discussed, leg length is best controlled during pre-operative planning.

Bilateral total hip arthroplasty is possible using the MIS anterolateral approach with the patient in supine position. The procedure is not more complicated than that for a unilateral total hip arthroplasty.

Blood loss is reduced as with all MIS approaches, compared to conventional surgery. The small incision made during MIS surgery causes less muscle trauma and damage to blood vessels. Patients with a low pre-operative haemoglobin value get a blood retransfusion. In general, these patients are less likely to require a blood transfusion. Blood retransfusion provides obvious benefits for the patient and cost savings for the hospital.

Following MIS surgery, patients have less pain and rehabilitate faster than after conventional surgery.

Patients have a post-operative pain management program in the author's hospital. Most patients have very little pain after surgery and stop the pain management programme after 1 or 2 days. On the day after surgery, the patient is encouraged to stand and walk short distances with the aid of crutches. The patient is encouraged to walk further on the second day after surgery. On discharge from hospital (usually 9 days post-operation), the patient has already climbed stairs with the aid of crutches.

There is less risk of posterior dislocation or gluteus weakness with the MIS anterolateral approach than with other approaches. The author reports a dislocation rate of 0.2% for this approach.

Post-operative infections rarely occur after MIS surgery. The author has encountered infections in only 0.3% of cases with total hip arthroplasty by this MIS anterolateral approach.

The average hospital stay of patients is 9 days as opposed to 12 days by conventional surgery.

Post-operative recovery time to walk unaided depends on the type of implant and the age of the patient. In general, patients with cementless implants are able to walk after 2 weeks. However, they are recommended to walk with crutches for 6 weeks until the implant has full weight bearing osteointegration. Use of crutches improves the stability of patients and reduces their likelihood of falling during walking. A fall during this period is more likely to result in bone fracture. Patients with cemented implants (usually elderly patients) are allowed to walk without crutches after 4 weeks, unless they have other movement restricting conditions. Full weight bearing is allowed from day 1 with cemented implants.

On an average, the patient can expect to return to normal activities 6 weeks after surgery.

The incision scar after MIS is smaller and less visible than the scar caused by conventional surgery.

7.4 Disadvantages

A disadvantage of the MIS anterolateral approach with the patient in supine position is the learning curve, necessary to achieve precise placement of implants.

The risk of fracturing the greater trochanter during the insertion of a femoral stem is more associated with the choice of implant rather than the surgical approach. The author prefers to use a short stem implant which does not touch the greater trochanter.

7.5 Patient Positioning/OP Field (Fig. 7.1)

7.5.1 Patient Positioning

Patients are given a low dose of low-molecular weight heparin (Fraxiparin®) on the evening before surgery to reduce the risk of deep vein thrombosis (DVT). A special compression sock is worn on the contralateral foot during surgery and on both feet after surgery. In addition, a venous pump system is started 2 h after surgery.

Patients are routinely given single-shot cephalosporin as infection prophylaxis prior to surgery.

The patient is placed in a supine position on a standard operating table with two separate leg supports. The contralateral leg is fixed to prevent it from slipping during surgery. A foam cushion between the contralateral leg and the leg rest protects the peroneal nerve, if the leg slips inadvertently. During the acetabular preparation the contralateral leg is only slightly abducted (10°) For the femoral preparation in addition it is hyperextended (15°). A sterile cloth sack is used to drape the contralateral leg.

The leg to be operated on is disinfected and standard coverings are applied. The leg remains mobile during surgery and is slightly flexed by positioning a knee roll below the knee. The knee roll is necessary only during acetabular preparation.

General anaesthesia is used at the discretion of the anaesthetist.

The surgeon stands in front of the patient and is attended by two assistants. The first assistant stands to the left of the surgeon and holds the retractor and suction device during acetabular preparation. The second assistant stands on the other side of the table opposite to the surgeon. During femoral preparation, the second assistant externally rotates the leg to be operated on, flexes the knee, and holds it to his or her chest in best possible adduction and extension. The surgeon then changes position with the first assistant. The first assistant holds the retractor which exposes the trochanteric region.

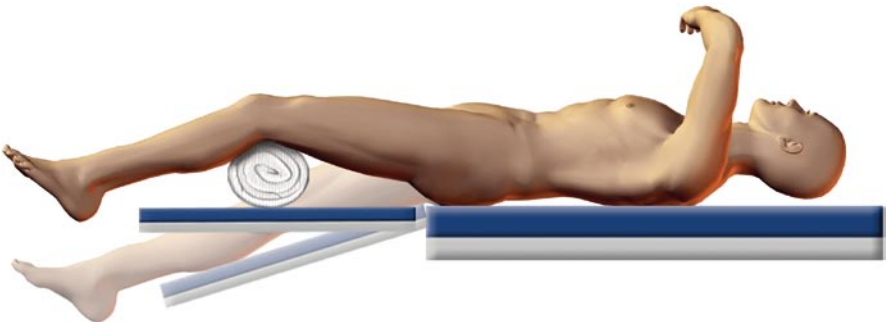

Fig. 7.1 Positioning of the patient. Please note the hyperextension of the contralateral leg is only used during the femoral preparation. This reduces the time of hyperexetension and therefore the incidence of lumbar back problems

7.5.2
Surgical Instrumentation

In general, standard instruments can be used for the approach. Only a few specialised instruments are necessary.

An oscillatory saw with a long stiff narrow blade (10–12 cm × 2.0–2.5 cm) is used to osteotomise the femoral neck. The femoral head is removed using an appropriately sized cork screw type extractor. This cork screw type extractor should neither pull out of the femoral head nor fracture the head during extraction.

The acetabulum is reamed with a power reamer. As with all MIS approaches there is a risk of reaming the acetabulum asymmetrically. To avoid this, the author first deepens the acetabulum with a small reamer (40 mm diameter). Afterwards, a large reamer is used to ream the peripheral acetabulum. The author recommends that the diameter of the final reamer is 2 mm smaller than the acetabular cup in uncemented implants, and 2 mm bigger in cemented implants.

The femoral canal is opened with a box chisel. The choice of instrument for reaming the femur depends on the type of stem to be implanted. An anatomic reamer is normally used for a curved stem and a straight reamer for a straight stem. The tip of the reamer should be curved to avoid perforating weak bones.

The progress of reaming the femur is checked against the pre-operative plan and the positions of the greater and lesser trochanter. A C-arm should be used to check the position of the last reamer. This is done after the last reamer is fitted with the trial head and the hip is reduced.

The instruments for implanting a specific brand of hip prosthesis are usually product specific and are supplied by the manufacturer.

7.5.3
Hip Prosthesis

There are no limitations on the type of prosthesis implanted using the MIS anterolateral approach with the patient in supine position. The choice of prosthesis depends on the indication and preference of the surgeon. The author prefers short curved femoral stems as they are easier to implant than straight stems.

7.6
Surgical Technique

7.6.1
Incision and Approach

While the patient lies in a supine position, the iliac crest is palpated to locate the position of the anterior superior iliac spine. A guideline for the skin incision is drawn between the iliac spine and the ventral upper end of the trochanter. The skin incision begins 4 cm proximal to

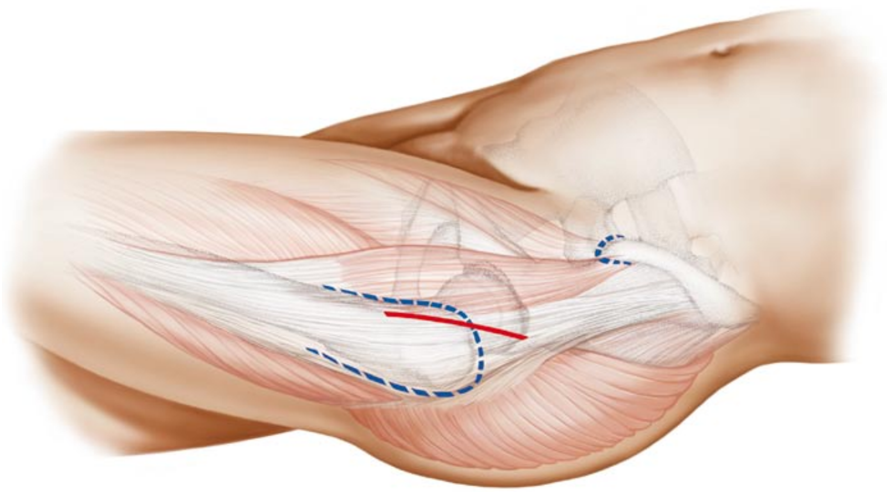

Fig. 7.2 The skin incision is centered on the proximal ventral end of the greater trochanter

the greater trochanter and normally extends 4 cm distal to the greater trochanter along the main axis of the femur. The incision is centred on the ventral tip of the greater trochanter. The average length of the incision is 8 cm but varies between 6 and 10 cm depending on the BMI and sex of the patient. The skin incision is normally 1 cm longer at the end of surgery due to stretching of the skin. However, 6 weeks after surgery, the skin scar is around 1 cm shorter than the original incision due to the scarring process (Fig. 7.2).

Subcutaneous fat is incised and retracted in line with the skin incision. Two skin retractors are recommended for this purpose. The underlying fascia lata is opened exactly in the same direction as the skin incision. A finger is inserted into the incision to check for the lateral (ventral) border of the gluteus medius and gluteus minimus. The finger makes a blunt dissection at the border of the muscles down to the joint capsule (Fig. 7.3).

Two curved Hohmann retractors with no sharp edges are positioned above and below the ventral capsule of the hip joint to protect the muscles. In 80% of patients, it is possible to bring the Hohmann retractor around the ventral rim of the acetabulum to expose the joint capsule. In some male patients, the caput reflexum insertion on the joint capsule is strong and must be cut before the Hohmann retractor can be brought around the ventral rim of the acetabulum (Fig. 7.4).

The vastus lateralis muscle is not displaced unless previous surgeries have resulted in strong attachments on the ventral capsule. The exposed joint capsule is cleaned prior to capsulectomy (Fig. 7.5).

7.6.2 Preparation of the Femoral Neck

The incision of the capsule begins at the lateral end of the femoral neck apically and extends ventrally and then caudally. This incision should include the complete proximal

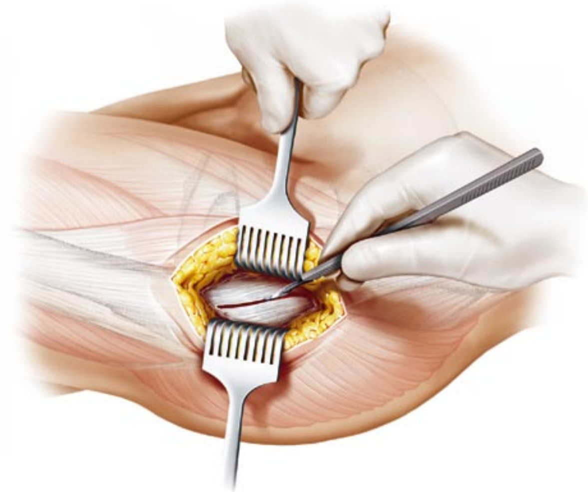

Fig. 7.3 The incision of the fascia lata. Take care not to be too ventral for not incising the fascia of the M. tensor fasciae latae.

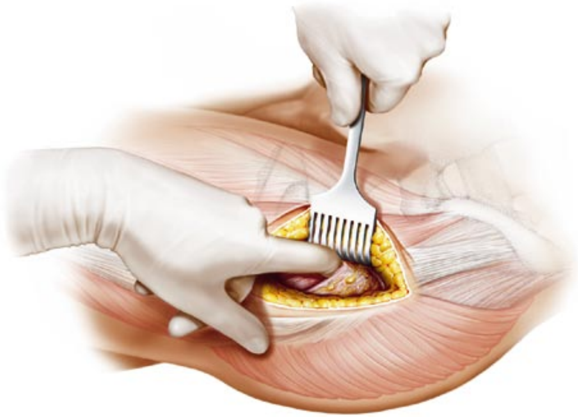

Fig. 7.4 Blunt dissection with the finger to the ventral upper part of the joint capsule.The M. gluteus medius and the M. gluteus minimus lay on the dorsal side of the dissecting finger

ventral and distal part of the capsule. The next incision is made ventrally above the femoral neck and as much capsule as possible is removed. Care is taken to avoid damaging the muscles around the capsule while performing the capsulectomy. Patients with arthrosis have few blood vessels in the vicinity of the joint capsule. Bleeding from muscles around the joint capsule is rarely seen in these patients when capsulectomy is done carefully. The two curved Hohmann retractors are repositioned in the capsule around the neck of the femur (Fig. 7.6).

The operated leg is then given a slight external rotation.

A single osteotomy is performed on the femoral neck with a long stiff bladed oscillating saw. Only in heavy patients with strong muscles and or big osteophytes a double osteotomy is performed. The removal of a segment of the femoral neck helps to extract the

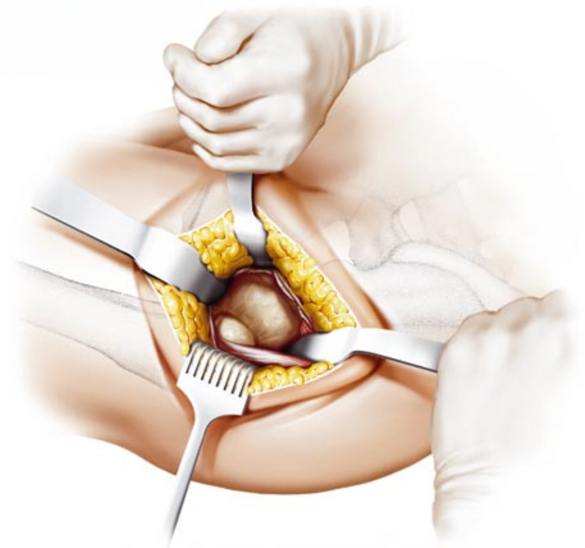

Fig. 7.5 The exposure of the femoral neck before the osteotomy with two facing curved retrators and one homann retractor without sharp end around the ventral rim of the aceabulum

Fig. 7.6 The situs after the osteotomy of the femoral neck

femoral neck. A wide chisel is inserted to make sure the cut is complete. The chisel is twisted to ventrally expose the femoral neck. The femoral head extractor is inserted into the proximal part of the femoral neck. The two Hohmann retractors around the femoral neck are removed. A small Langenbeck retractor is inserted proximally to protect the gluteus medius and gluteus minimus. The femoral head is removed from the acetabulum by firmly pulling and twisting the extractor with both hands. In approximately 5% of patients, it is necessary to make a second osteotomy on the femoral neck and reinsert the extractor deeper into the femoral head before the head can be removed. Two osteotomies are also necessary when the femoral neck is varus deformed and when pronounced acetabular osteophytes are present (Figs. 7.7 and 7.8).

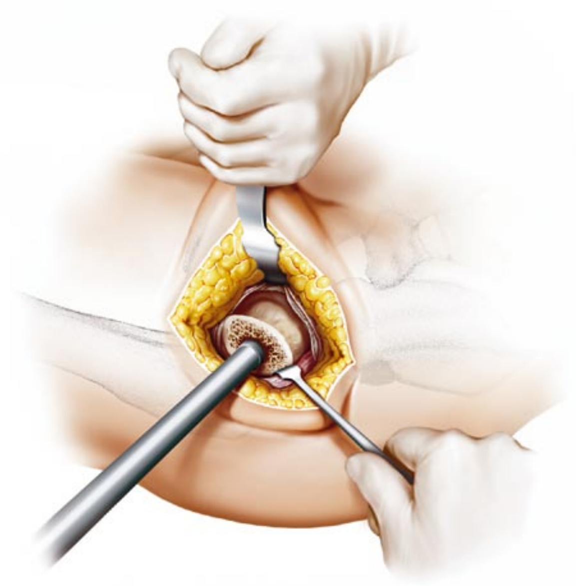

Fig. 7.7 Head extraction

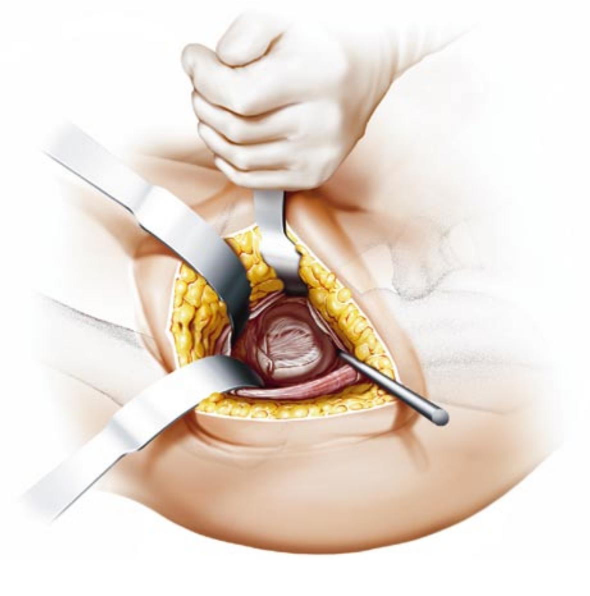

Fig. 7.8 Retractor placement for the acetabular preparation

7.6.3 Preparation of the Acetabulum

After the femoral head is removed, a Steinmann pin is inserted at the apical end of the acetabulum. This is necessary to retract the gluteus medius and gluteus minimus without having to use a retractor. The capsule is raised with forceps and the whole apical capsule and part of the dorsal capsule is excised. A curved retractor is placed at the distal end of the acetabulum and a wide retractor is positioned to displace the femur down and to the lateral side.

The remainder of the capsule is removed to improve exposure of the acetabulum.

Power reaming with a small diameter head deepens the acetabulum. This is followed by reaming of the peripheral acetabulum with a large diameter head. This technique avoids asymmetrical reaming. The peripheral acetabulum is under-reamed by 2 mm for optimal fitting of the acetabular cup (uncemented technique).

Further preparation of the acetabulum depends on the type of acetabular cup being implanted. Cemented cups are inserted with 2 mm over-reaming of the acetabulum. Three holes (5 mm diameter × 10 mm deep) are drilled in the acetabular bone prior to the insertion of cemented cups. Press-fit cementless cups require no further preparation of the acetabulum before insertion.

Osteophytes are removed to avoid post-operative problems such as impingement.

The acetabular cup is inserted with appropriate straight or curved instruments depending on the type of implant. The operated site is rinsed with saline (Fig. 7.9).

7.6.4 Preparation of Femur

The knee roll is removed from below the operated leg. The contralateral leg is hyperextended by changing the leg support of this leg. A curved Hohmann retractor is brought

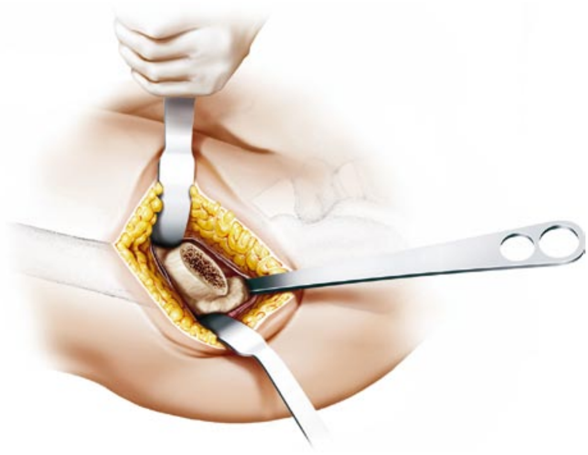

Fig. 7.9 Positioning of the retractors for the femoral preparation. Note the tip of the proximal (straight) retractor is positioned at the trochanter for straight stems preparation whereas for curved (short stems) it is positioned at the dorsal (medial) cortical end of the neck of the femur

around the dorsal side of the greater trochanter to displace the fascia lata dorsally. This improves exposure of the proximal femur when the operated leg is repositioned.

The operated leg is externally rotated (90°) and flexed at the knee joint (70°). The leg is held in maximum adduction and extension by the second assistant.

A curved retractor is placed at the top of the femur to displace soft tissues on the ventral side.

The proximal femur is exposed with the aid of a straight Hohmann retractor in the 5 o'clock position (left leg) or the 7 o'clock position (right leg).

Exposure of the proximal femur is further improved by removing the remainder of the capsule on the femoral side.

The femoral canal is opened with a box chisel. The canal is widened with progressively larger reamers. Curved or straight reamers are used depending on the type of femoral stem to be implanted. Curved reamers prepare the canal for insertion of a curved or anatomic stem. The progress of reaming is checked against the pre-operative plan and the positions of the greater and lesser trochanter.

Broaches are introduced with a double offset handle. The final broach is used as a trial femoral stem and is fitted with a neck and trial head. The hip is reduced by extending and internally rotating the operated leg. A single shot X-ray of the hip is taken and the positions of the acetabular cup and broach are checked against the pre-operative plan.

Reluxation of the hip is followed by removal of the trial stem and insertion of the definitive stem. The same trial head is fitted to the stem and the hip is again reduced. A single shot X-ray is taken and the positions of the acetabular cup and definitive stem are checked against the pre-operative plan. The hip is reluxed and the definitive head is inserted in the acetabular cup (Fig. 7.10)

7.6.5 Reduction

All components of the prosthesis are in position and the operated site is rinsed with saline to remove tissue debris. One Langenbeck retractor is retained ventrally to protect the muscles during reduction.

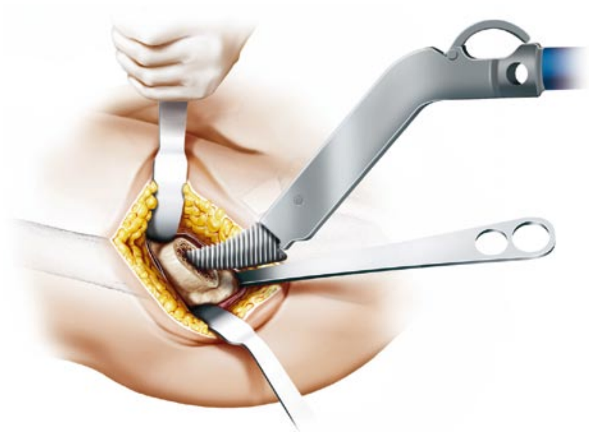

Fig. 7.10 Femoral reaming. Note the proximal (straight) retracor is a long retractor for not disturbing the reaming instrument

Lidocaine (Xylocain®) and adrenaline are injected into subcutaneous tissues and around the capsule as part of the pain management programme in the author's hospital.

The operated leg is extended and internally rotated to reduce the hip.

7.6.6 Closure

Three aspiration drains are placed in the operated site for 48 h. Two drains are placed deep below the fascia lata and one is placed superficially in the wound cavity.

The fascia lata and subcutaneous tissue are each sutured with five stitches. The skin is sutured with staples or intracutaneous resorbable stitches for cosmetic reasons.

7.7 Post-Surgical Care and Rehabilitation

7.7.1 Immediate Post-Surgical Care

The patient is moved from the operating table to the recovery bed. To avoid hip dislocation, the operated leg should not be externally rotated.

The operated leg is placed in the neutral position in a foam splint to minimise the risk of dislocation.

Analgesics (paracetamol and opiates) are administered post-operatively according to the intensity of pain reported. Diclofenac (150 mg/day) is normally given for 2 weeks to prevent peri-articular ossification. Elderly patients are taken off diclofenac, if they experience any side effects due to this medication, despite the stomach protection used.

Patients are allowed to place full body weight on the operated leg 1 day after the operation with cemented implants, and half of their body weight for 2 weeks after the operation with uncemented implants. However, they are not advised to cross their legs or flex the hip by more than 70° for 2 weeks. Patients are recommended to use crutches for 4–6 weeks.

Low dose of a low-molecular weight heparin (Fraxiparin®) is administered once daily, and patients are advised to wear special compression socks on both feet to minimise the risk of DVT. A venous pump system is started 2 h after surgery.

7.7.2 Physiotherapy

Physiotherapy is important for the fast rehabilitation of patients. The extent of physiotherapy permitted and the rate of rehabilitation depends obviously on the age and health status of the patient.

7.8 Complications

Three main intra-operative complications can occur. First, the gluteal muscles may be damaged during dissection. This is more likely when the intermuscular interval is not properly identified. Second, the superior rim of the acetabulum can be damaged by over-reaming with a curved reamer. Third, the greater trochanter can be fractured by not using the appropriate instruments to ream the femur or by mal-positioning of a retractor.

7.8.1 Pre- and Intra-Operative Events

False positioning of acetabular and femoral implants is the main complication with all MIS approaches. Over-reaming can damage the ventral border of the acetabulum and lead to high positioning of the acetabular cup. Lack of good primary stability of the acetabular cup can also lead to problems. Inexperienced surgeons should be particularly careful to achieve good primary stability when inserting an acetabular cup. Perforation of the femur and periprosthetic fractures may cause false positioning of a femoral stem. Lack of pre-operative planning can lead to incorrect offset and leg length discrepancy.

Later problems with hip luxation may occur as a result of leg length discrepancy.

In case of intra-operative problems, the MIS anterolateral approach can be extended.

7.8.2 Post-Operative Events

There are no post-operative complications specific for the MIS anterolateral approach with the patient in supine position.

7.9 Personal Experience, Outcome and Success Rate

During the last 25 years, the author has performed approximately 2400 total hip arthroplasties. The majority of these total hip arthroplasties were by the anterolateral approach.

About 750 hundred of these cases were operated on using the MIS anterolateral approach. The author has achieved a success rate of 97% with this approach.

Revision surgery was necessary in five cases. Revisions were made for femoral fractures (two cases), trochanteric fractures (two cases) and deep infection (one case).

In author's hospital, the blood transfusion rate in primary hip surgery is only 3.7%.

According to the author, patients are more satisfied with the MIS anterolateral approach than with conventional surgery.

The approach reduces hospital stay by approximately 3 days and gives estimated cost savings of 20%.

Bilateral total hip arthroplasty is possible with the MIS anterolateral approach. The procedure is not more complicated than that for a unilateral total hip arthroplasty. Indeed, the second total hip arthroplasty normally takes less time to perform than the first operation. The author performed bilateral implants in 18 patients in 2008.

A surgeon wishing to learn the MIS anterolateral approach requires cadaver laboratory training, and education from an experienced surgeon. The author considers the approach, to be easy to learn and easy to teach. Nevertheless, a learning curve is necessary before a surgeon can achieve precise placement of implants.

According to the author, a surgeon with no previous experience in hip replacement surgery can consider himself or herself proficient with the MIS anterolateral approach after approximately 50 surgeries. A surgeon familiar with other approaches in hip replacement surgery can expect to become proficient with the approach after ten surgeries.

The author summarises what he considers as the main advantages of using the MIS anterolateral approach with the patient in supine position as follows: small incision, no damage to muscles, low risk of damage to nerves, easy and fast positioning of the patient on the operating table, easy anatomical orientation, and short operation time.

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8 The Posterior Approach[1]

Modaine J

8.1 Introduction

Minimally invasive surgery (MIS) by the posterior approach is described in this chapter. Like other MIS techniques, the approach was developed from conventional surgery.

Bernard von Langenbeck described the first posterolateral conventional approach for THA in 1874 [1]. According to Tronzo [2], at least 13 distinct variations of the approach have been described since then. The most noteworthy of these were modifications made by Kocher [3], Gibson [4], and Moore [5].

The Kocher-Langenbeck posterolateral approach [3] is well known and is popular among orthopaedic surgeons in France. The technique is easy to learn and is commonly used for repairing fractures of the femoral neck.

The posterolateral approach of Gibson [4] was modified into a true posterior approach by Moore [5].

The MIS technique described in this chapter is a modification of the conventional approaches developed by Moore and Kocher-Langenbeck.

The author, Dr. J. Modaine from Lievin (France), has performed 450 THAs using the MIS posterior approach. This approach is extensible and, if necessary, can be converted to the conventional approach at any time during surgery. The femoral preparation is easier than with anterior or anterolateral approaches, and leg length is easily controlled. No cases of postoperative limping have been found. Patient satisfaction with the MIS posterior

[1]Please make yourself familiar with the handling of the instruments, the product-related surgical technique and the warnings, the safety notes as well as the recommendations of the instruction leaflet before using an implant manufactured by Mathys Ltd Bettlach. Make use of the Mathys user training and proceed according to the recommended surgical technique.

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approach is high. After this approach, patients can expect to rehabilitate faster than after conventional surgery.

8.2 Patient Selection

8.2.1 Examination

Full sized plain radiographs of the pelvic region are made in the anteroposterior and lateral planes. The anteroposterior radiograph shows the inclination angle of the acetabulum.

8.2.2 Indications

There are four indications for THA: arthritis, necrosis of the femoral head, rheumatoid arthritis, and fractures of the femoral neck in young patients. These indications also affect different age groups. Patients presenting with necrosis of the femoral head are aged 35–50 years, and in the author's experience, the necrosis is often due to alcoholism. Patients with arthritis are usually elderly (60–85 years). Patients with a femoral neck fracture who are elder than 70 years can benefit from a THA.

The MIS posterior approach is suitable for all patients of any age.

High BMI is not a problem for the approach. The author operates on overweight and even obese patients using the smallest incision possible, while maintaining the good soft tissue management of the MIS approach.

Revision surgeries for malpositioning of the acetabulum and dislocations are possible with a low invasive posterior approach. The difficulty is to remove a cup while the stem remains in the femur.

Bilateral THA is possible using this approach but it is not recommended. The author has performed bilateral THA in only two cases where spinal anesthesia was not possible. These cases had ankylosing spondylarthritis with a major stiffness of the cervical spine and needed endoscopic intubation.

After a THA by the MIS posterior approach, patients recover faster and rehabilitate better at 1 month post operation than with conventional surgery. However, the quality of life for patients at 3 months post operation is usually the same regardless of surgical approach.

8.2.3 Contraindications

Congenital high dislocation of the hip (CDH) is the most important contraindication for the MIS posterior approach.

Patients with bone tumors should not be operated on by this MIS approach.

Certain revision surgeries to reinforce bone and correct for defects are also exclusion criteria.

Other contraindications for this approach are the same as those for conventional THA approaches.

8.3 Advantages

The main advantage of the MIS posterior approach is the operative safeguard. For example, during a difficult operation, the MIS approach can easily be converted to a conventional one without affecting the operation time.

The MIS posterior approach allows good positioning of the acetabular prosthesis, control of leg length, as well as placement of cemented and uncemented stems.

The author developed a technique for retracting pelvic muscles so that they protect the sciatic nerve from damage during surgery. No injuries to the sciatic nerve have occurred during surgeries performed by the author.

Postoperative recovery time is short: on average, 3–4 weeks. After 1 month, patients normally do not require crutches and can return to their daily activities.

An additional advantage of the MIS posterior approach is that operations can be performed on a standard surgical table, and there is no need for a special table .

8.4 Disadvantages

The main disadvantage with any posterior approach (MIS or conventional) is the risk of posterior dislocation of the hip. The length of the incision used on pelvic muscles and the quality of their repair to the bone influence the risk of dislocation. In the author's experience, the MIS posterior approach has less risk of dislocation than conventional surgery due to the smaller muscle incision.

8.5 Patient Positioning/OP Field

8.5.1 Patient Positioning

The patient is placed in a lateral position on a standard surgical table. (Fig. 8.1) It is essential that the pelvis is well balanced and in a vertical position. Two cushions are placed posterior and anterior to the pelvis to block movement during the operation.

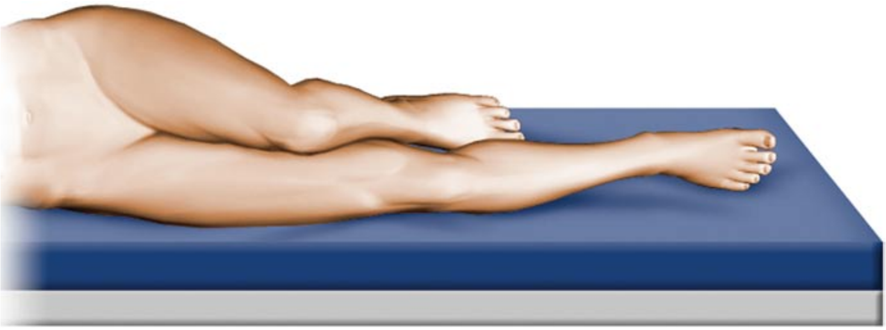

Fig 8.1 Patient Position in lateral decubitus

A standard incision drape is used to cover the hip. Special external covers are important for the laminar airflow system in the operating room (OR).

Patients are anesthetized according to the convalescence program they will follow: conventional or rapid recovery. With the conventional program, spinal and epidural anesthetics are given in combination. Spinal anesthesia provides the motor motion block while epidural anesthesia limits postoperative pain. With the rapid recovery program, patients are given general anesthesia and have a nerve block with buvipacaïne or rovipacaïne to limit postoperative pain. A morphine pump is also used. The surgeon stands behind the patient and is assisted by two nurses: a "scrubbed nurse" for instrumentation and another one to help and keep position of the leg to be operated on. The nurse holding the leg controls the position of the femur in the "mobile window" of the incision where the surgeon is operating.

Compression stockings (type 2) are worn after surgery to reduce the risk of deep vein thrombosis (DVT).

8.5.2 Surgical Instrumentation

Standard surgical instruments with long handles are preferred for the MIS posterior approach. Included are scalpels, forceps and retractors.

Specialized instruments necessary for the approach are reamers, and prosthesis impactors.

A blunt self-retaining retractor is needed to retract the skin and subcutaneous tissues.

Hohmann retractors (No's 1, 3 and 7), ventral retractors, and posterior retractors are required for deeper surgery. When necessary, the author attaches a weight to one of these retractors to keep it in position.

An oscillatory saw with a long blade is required to cut the femoral neck. The femoral head is removed according to the method favored by the surgeon. The author uses a femoral head extractor.

The acetabulum is prepared with a Chana reamer. The offset arm allows the head of the reamer to be optimally positioned for cutting. An offset or curved impactor is used to implant the acetabular cup and a suction pad to insert the inlay.

The author uses a straight rasp to open the medullary canal.

Instruments for implanting a hip prosthesis are usually product specific and supplied by the manufacturer of the prosthesis.

8.5.3 Hip Prosthesis

The choice of prosthesis depends on the indication of the patient and the preference of the surgeon.

Normally, most cemented or uncemented prostheses can be implanted by the MIS posterior approach. Exceptions are threaded cups which require a straight impactor for implanting. The MIS posterior approach does not provide good access for a straight impactor, and the author advises against implanting threaded screw-fit cups with this approach.

The author prefers to implant straight femoral stems with a flattened shoulder and press-fit acetabular cups with ceramic inlays.

8.6 Surgical Technique

8.6.1 Incision and Approach

The principle of this approach is to create a "mobile window" to give optimal view of the part of the hip being operated on. When operating on the acetabulum, it is not possible to see the femur through this window. Similarly, when the femur is pushed into the window, it is not possible to see the acetabulum.

With the patient lying in a lateral position, the greater trochanter is palpated. A reference point for the skin incision is marked at a point which is two thirds of the width of the greater trochanter from its anterior margin (Fig. 8.2). The curved incision begins at this point and extends 6–8; cm proximally. One third of this incision lies distal to the greater trochanter while two thirds lies proximal. The length of the incision depends on the BMI of the patient and on the previous diameter of the femoral head. If necessary, the skin incision can be widened to improve exposure any time during surgery. An incision shorter than 6; cm increases the risk of skin bruising.

Subcutaneous fat is incised and retracted in line with the skin incision. A blunt tip self-retaining retractor is used. Hemostasis is achieved by electrocautery.

The fascia lata and gluteus maximus are incised in line with the long axis of their muscle fibers. These muscles overlap obliquely and this is reflected in the angular incision made. If necessary, the incision in the fascia lata can be extended under the skin incision. The incision in the gluteus maximus must be kept as short as possible to avoid damaging the gluteus maximus nerve. These incisions create a "mobile window" for surgery.

The author uses the following technique to ensure that the muscles are retracted over the sciatic nerve to protect it from damage. Firstly, the muscles are marked with a Lambotte

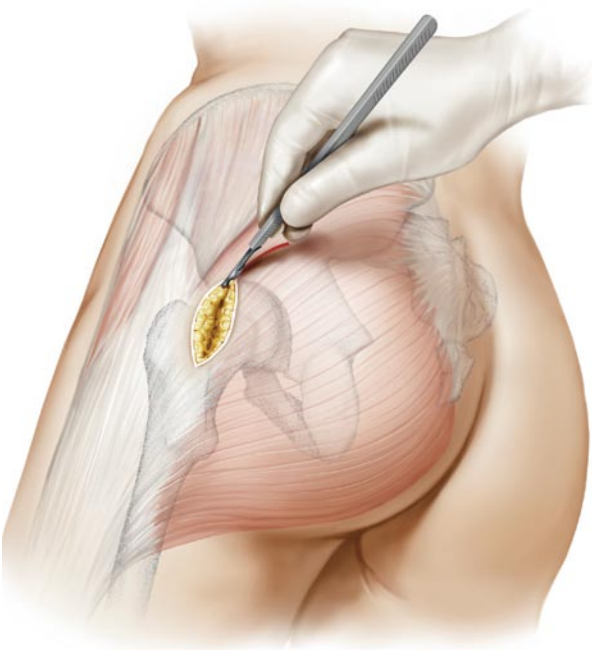

Fig 8.2 The skin incision size is 1.5 times larger than the diameter of the femoral head

raspatorium. A Hohmann retractor (No. 1) is inserted between the piriformis and gluteus medius at the upper part of the femoral neck. Another Hohmann retractor (No. 3) is placed under the neck and between the quadratus femoris and obturator interna (Fig. 8.3). The operated leg is put in a slight external rotation and abducted. This position gives good exposure of the obturator interna.

The muscle tendons to be detached are tagged with one hard suture. A knot is made at the lower (obturator interna) and the upper (piriformis) part of the muscle to be detached. A flap keeps the tendons at the correct size when the muscles are reattached onto the femur (Fig. 8.4).

The tendon of the piriformis and the cojoined tendon of the gemelli and obturator interna are detached close to their insertion point. The author recommends detaching tendons with an electrocautery tool which also contracts the muscles and makes them easily distinguishable from the capsule. Hemostasis of the circumflex vessels is achieved by electrocautery.

8.6.2 Preparation of the Femoral Neck

A posterior capsulectomy is performed by electrocautery to expose the femoral neck. A long electrocautery blade insulated with a plastic sleeve protects soft tissues and skin from heat damage. The author prefers to resect (rather than resuture) the capsule as it contributes to stiffness of the hip.

The hip is dislocated by the preferred method (the author uses a dislocation hook).

The position for cutting the femoral neck is marked according to the preoperative plan. This is done with a ruler and using the lesser trochanter as a reference point.

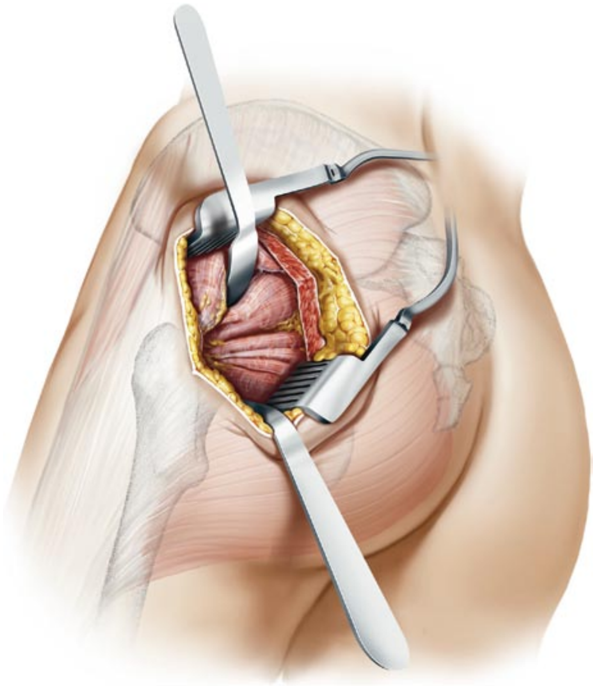

Fig 8.3 Superficial exposition. Blunt tip selfretaining retractor for skin and subcutaneous fat. Hohmann retractor between M. piriformis and M. gluteus medius to the upper part of the femoral neck. Hohmann retractor to the lower part of the femoral neck between M. quadratus femoris and M. obturatus externus

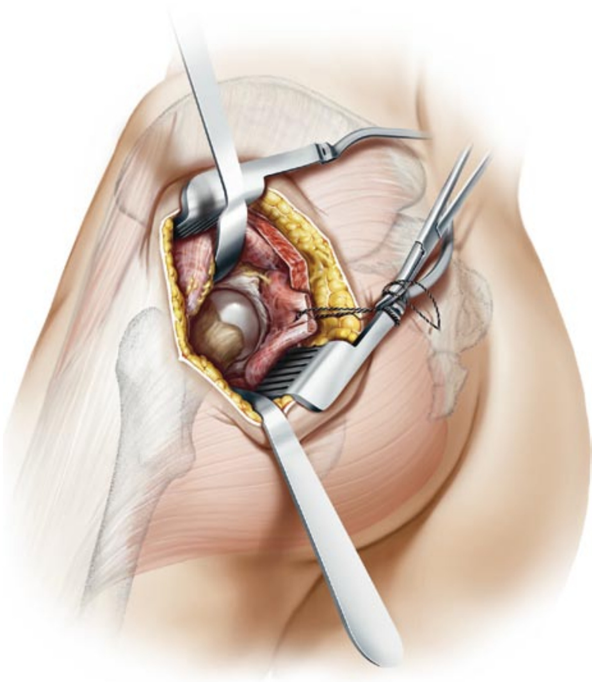

Fig 8.4 Capsulectomy and exposing of the femoral head: Make sure the pelvitrochanteric muscles are between the hook and the sciatic nerve in order to protect it. The external rotators are detached

Center of rotation of the femoral head is measured in order to control leg length at the end of the procedure. Osteotomies on the femoral neck are performed with a long bladed oscillatory saw.

8.6.3 Preparation of the Acetabulum

The anterior capsule is exposed and resected by placing the anterior retractor under the anterior lip of the acetabulum.

Capsulectomy (both anterior and posterior) is completed and the labrum excised. This reduces the risk of any tissue impinging between the acetabulum and cup when implanting. Complete capsulectomy also reduces the stiffness of the hip and this makes the femoral step easier.

The transverse ligament between the anterior and posterior lips of the acetabulum is located and excised. The excision of this ligament is an important landmark for positioning the acetabular cup.

A Steinmann pin is inserted at the posterior lip of the acetabulum. The inferior retractor is placed under the inferior part of the acetabulum, and pushes back the psoas muscle to optimize exposure of the acetabulum.

Medial osteophytes from the deepest point of the acetabulum and then anterior osteophytes are removed.

The acetabulum is reamed with an offset reamer until the bone begins bleeding. The size of the last reamer should have a diameter, 2 ;mm (or one size) smaller than the width of the implant. However, the head size of the last reamer may vary depending on the type of cup to be implanted (Fig. 8.5).

The acetabular cup is positioned with 45° of inclination and 20° of anteversion. A special curved impactor with an offset is used for final impaction. The author uses a special suction pad to ensure that the cup inlay is inserted in the same axis as the cup.

8.6.4 Preparation of the Femur

The operated leg is repositioned in a vertical position and given an external rotation. Internal rotation (15°) is then applied to position the femoral neck in anteversion. The nurse puts pressure on the knee to shift the stump of the femoral neck into the mobile incision window for surgery.

A Hohmann retractor is inserted between the psoas and the femur. The femur is then raised by placing another special retractor with a weight attached below the anterior femoral neck. This retractor lateralizes the femur and also protects the soft tissues from the rasp during reaming (Fig. 8.6).

A notch is made on the femoral neck with a box chisel to mark the entry point for the rasp. Loose bone is scraped away with a spoon and the medullary canal, opened up with an awl or a soft spoon. This ensures that the rasp is correctly orientated in the medullary canal during reaming.

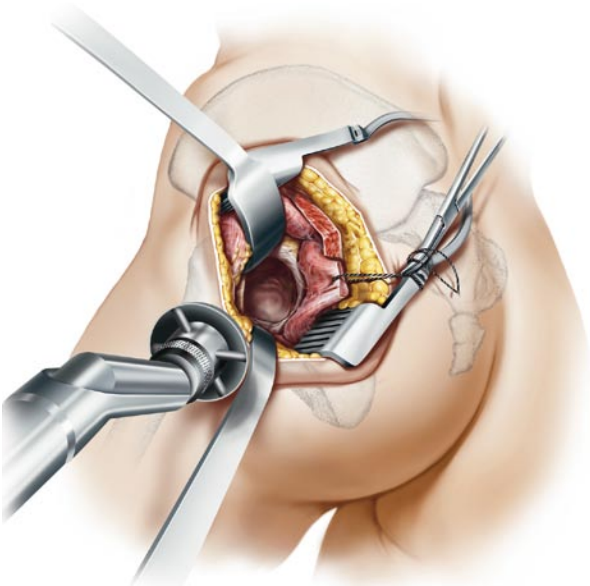

Fig 8.5 Exposing of the acetabulum for the reaming

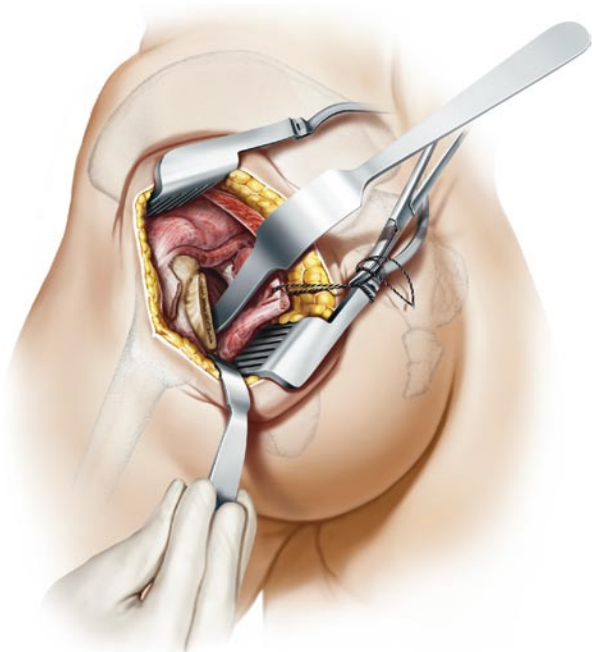

Fig 8.6 Exposing of the femur by moving of the mobile window

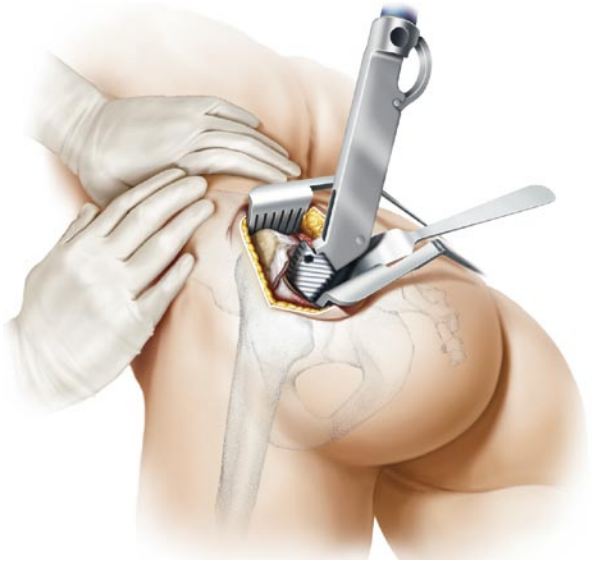

Fig 8.7 Preparation using the femoral rasps

The femur is reamed with straight rasps of increasing size according to the preoperative plan. Reaming is stopped when the rasp is close to cortical bone; i.e., it no longer rotates in the medullary canal and makes a different cutting sound (Fig. 8.7). The final rasp should be at the level of the femoral neck cut.

The femoral stem is implanted, and the femur, restored to standard position by pushing back on the knee (Fig. 8.8). The neck of the implant is now in the incision axis and passes under the muscle and suture. The author uses the stem impactor to help move the neck of the implant through the incision window.

A trial head is inserted on the neck of the implant. The center of rotation of this head is checked to ensure that it is in the same position as the original femoral head or as previously on the preoperative plan. The author uses a ruler to check this.

A mistake occasionally made by inexperienced surgeons is to inadequately ream the femur. This can lead to varus positioning of the stem and must be corrected for by rereaming the femur.

If the neck length is shorter than required, then it is possible to use a higher femoral head in accordance with the preoperative plan. The definitive head is inserted when the centers of rotation are correctly aligned.

8.6.5 Reduction

The surgeon pushes on the femoral head with a reductor while the nurse pulls on the knee. Reduction is achieved by internally rotating the operated limb when the femoral head is in front of the acetabular cup.

When the limb is longer than preoperatively planned for, then there can be a conflict between the femoral head and the posterior part of the cup. In this case, reduction is achieved by raising the femur with a Lambotte hook and pushing the femoral head into the cup with a reductor.

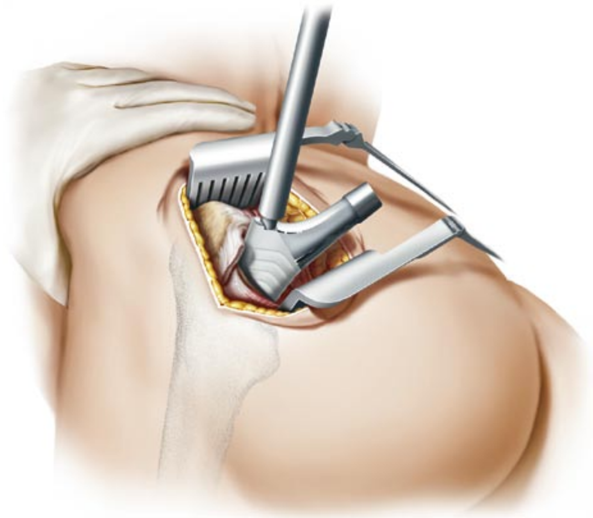

Fig 8.8 Insertion of the final implant

8.6.6 Closure

A pressure rinsing system is used to flush the wound with an antiseptic solution during surgery.

Two systems are used for wound drainage: deep drainage and under skin drainage kept in place for 2 or 3 days.

With the hip in a stable position, the piriformis tendon is resutured onto the bone. The resuturing needle is placed at the junction between the greater trochanter and the insertion of the gluteus medius. A small hole is drilled in the bone for attachment of the lower suture. The tendon is pulled into position. The author uses Flexiden No. 7 for reattachment.

The fascia lata, gluteus maximus, subcutaneous tissue, and skin are all sutured with a resorbable suture. One single thread is used to suture both the fascia lata and gluteus maximus. Intradermal stitches or staples are used to suture the skin.

8.7 Postsurgical Care and Rehabilitation

8.7.1 Immediate Postsurgical Care

The patient is transferred by stretcher from the operating table to the recovery bed.

Patients under epidural anesthesia are usually unable to move during the first night after surgery. No special precautions or supports are necessary to prevent hip dislocation in these patients.

Low-molecular-weight heparin is not given preoperatively. All patients receive an injection of heparin (50% full dose) in the evening on the same day as the operation. Full dose heparin is given on the day after operation and daily injections are continued for 42 days.

There are two different programs for convalescence in the author's hospital: conventional (8–10 days) and rapid recovery (average 6 days). Patients in the conventional program use a walking frame on the second day after surgery. With the rapid recovery program, patients are encouraged to begin walking with a frame (and later crutches) in the afternoon of the first day after surgery. Some patients may feel fit enough to be discharged after 5 days.

Full range of motion with the operated leg is allowed with two exceptions: no external rotation until 1 month post-op; and no leg crossing until 3 weeks post-op. This reduces the risk of dislocation. Complete recovery is not expected until 3 months. During the recovery period, the author recommends his patients to be careful with their activities to avoid hip dislocation.

8.7.2 Physiotherapy

Physiotherapy is an important part of the rehabilitation process. Patients in the rapid recovery program at the author's hospital undertake a special program for physiotherapy. These patients attend twenty physiotherapy sessions during the first month post-op. Sessions are daily to begin with and every 2 days thereafter.

8.8 Complications

8.8.1 Pre- and Intra-Operative Events

Fracture of the greater trochanter is the main intra- and postoperative complication specific to the MIS posterior approach. The risks of fracture and stem malpositioning (varus) are normally reduced as the surgeon becomes more experienced with the technique. Good preoperative planning and adherence to the plan are also important in reducing the risk of fracture.

Special care should also be taken not to damage the circumflex vessels (especially the vein) during surgery. Achieving hemostasis of circumflex vessels is particularly difficult during MIS and failure to do so can lead to greater blood losses with this approach than with conventional surgery.

8.8.2 Postoperative Events

The major risk with all posterior approaches (MIS and conventional) is posterior dislocation of the hip. In the author's experience, the MIS posterior approach has less risk of dislocation than conventional surgery due to the smaller muscle incision.

8.9 Personal Experience, Outcome and Success Rate

During the past 21 years, the author has performed approximately 2,200 THAs by the posterior approach.

Four hundred and fifty of these cases were operated on with the MIS posterior approach in the last 3 years. A high success rate (95%) has been achieved with this approach.

According to the author, the rate of complications with the MIS posterior approach is normal and not different from that encountered by other surgeons performing posterior approaches.

Blood loss is also no greater than with conventional surgery.

No postoperative infections were encountered by the author. Only minor skin bruising, caused mainly by impingement from rasps occurred.

Furthermore, revisions due to implant instability were necessary in only 2–3% of cases operated on by the author.

According to the author, the average operating time with the MIS posterior approach is 40 ;min for an experienced surgeon.

Patients recover more rapidly after MIS than after conventional surgery.

Good patient satisfaction has been achieved with MIS. Patients usually refer to the short incision scar as the main reason for their satisfaction.

Any surgeon wishing to learn the MIS posterior approach needs to first become proficient with the conventional posterior approach. The author recommends starting with a conventional incision and making it smaller as experience is gained.

According to the author, a surgeon can be considered proficient with the MIS posterior approach after performing a minimum of 20–25 THAs, if he/she is not already familiar with the conventional posterior approach. A surgeon already familiar with the posterior approach could perhaps achieve proficiency in MIS only after 5–10 THAs.

The author suggests that cost savings should be possible if patients spend less time in hospital after THA by MIS than after conventional surgery.

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Epilogue 9

Werner Siebert

9.1 Trends in Total Hip Arthroplasty

Total hip replacement has made a remarkable contribution to a lifestyle restoration of many patients in the past. Currently, there are approximately 1 Mio. total hip procedures performed annually, and this number can be expected to grow in the future, because life expectancy is increasing worldwide. More than 50% of the European population aged 50 or older has some kind of arthritis or joint disfunction (Fig. 9.1).

Crowninshield reports in an overview that the incidence of self reported arthritis in the adult US population over time has doubled since 1985 [1]. Females dominate the arthritic population with twice as many females suffering from arthritis compared to men. The growing body mass index increases the problem. The incidence of obesity in the United States adult population has doubled in the past two decades. By contrast, European men are more likely to have a higher BMI than European women. Over 70% men and over 50% of women in Germany are overweight or obese. Obesity coincides with the fact that this group is more likely to have arthritis and receive a total joint replacement.

So what are the future trends for total hip replacement? The numbers will certainly grow, but also surgery will become more difficult, because our patients are morbid obese in many cases.

On the other hand, we also have to consider the requirements of the elderly who have high activity expectations.

The elderly are generally better educated today and have easier access to information. One of the trends in future total hip replacement surgery will be coping with the different levels of information our patients have when discussing medical problems. Due to direct consumer advertising and surgical information through internet, younger patients may seek treatment earlier, as they may be less accepting of a life with a disability. So our hip surgery in the future will not be the same as today.

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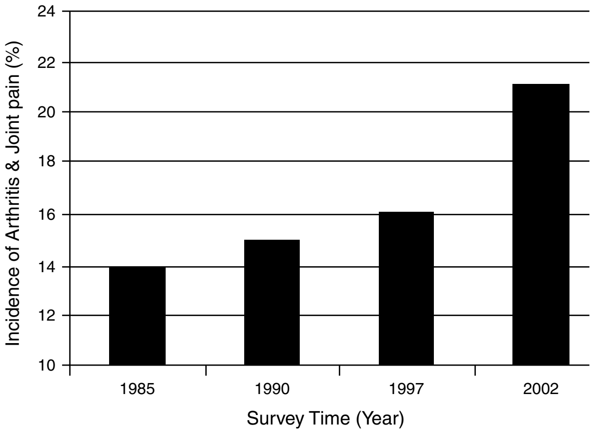

Fig. 9.1 The incidence of self reported arthritis in the adult US population over time; Crowninshield (Graphic from the Journal "Hip International" Fig. 3 Page 4)

Minimally invasive hip replacement will become a standard procedure and we must be prepared for this. Change is inevitable, but progress does not necessarily follow.

We witness two changes: one is minimally invasive surgery for total hip replacement; the other is computer-assisted hip replacement.

CT-based navigation and image-free navigation have gained some popularity especially in Europe. The discussion remains, whether there is a real advantage using these technologies.

Most studies available are case reports, nonrandomized and normally not prospective studies on this field. So, there is still no proof that computer-assisted surgery, including navigation, can show advantages over conventional surgery. The National Institute for Health and Clinical Excellence has provided an overview on single mini-incision hip replacement with many different papers [2]. There has been some randomized controlled trials with different approaches (Ogonda, Chimento, Lawlor [3–5]), which could not clearly show a significant difference in the outcome.

But there is also a study of Murphy and Tannast comparing conventional to minimally invasive total hip arthroplasty, where the authors conclude that the current study demonstrate the potential that less invasive surgical techniques with a philosophy of maximal preservation of the abductors posterior capsule and short rotators may result in a safer operation with an accelerated recovery [6]. They could find a statistically significant advantage for the minimally invasive procedure.

Future trends must also have economic considerations in minimally invasive total joint arthroplasty.

The study of Bozic and Beringer addresses economic considerations of patients, surgeons, hospitals and payers [7]. The authors conclude that minimally invasive total joint arthroplasty offers potential to reduce perioperative morbidity, shorten recovery time, and reduce the overall costs associated with total joint arthroplasty procedures. So this aspect is also an important trend for our future, because costs will play a more important role in health care decisions in the future.

Vail and Callaghan show in their overview on minimal incision total hip arthroplasty that two-incision mini direct lateral shows a higher complication rate than standard procedures, but other single incision mini approaches may be of advantage for the patient [8]. Currently, there are only early surgical outcomes and follow-ups available, but the trend shows that minimally invasive hip replacement is a winning concept and has already scored many points.

Overall, we will see new instrument designs, new implants, a more rapid rehabilitation programme, and a development of better pain control-protocols in the future.

We have realized that our previous incisions were longer than necessary. It may be that surgeons, who continue to practice with standard techniques, will gradually lose, just as those who failed to take up other minimally invasive techniques such as arthroscopy. So minimally invasive surgery, whichever approach we use, will definitely be a future trend in total hip arthroplasty.

Navigation still needs to prove that the longer operation time and the effort is justified by better clinical and long-term results. Concerning new implant designs, there is a tendency toward short stem devices and maybe even modular devices, which can better reconstruct offset and leg length and give a second line of defence in primary total hip arthroplasty. Navigation will probably find its place in the future in the minimally invasive surgery to make our incisions even smaller, less invasive and safer.

Minimally invasive procedures performed with special implants and special instruments have a longer learning curve than traditional procedures and more experience is needed to conduct them safely.

On the other hand, the procedures are very promising and the available short-term results of surgeons operating in high numbers are very encouraging.

With new implants and new tribology considerations, we will naturally have some advantages in the future, but the main factor in surgery is the surgeon and his techniques and ability to help his patients profit from his good training and less invasive methods. Accuracy of acetabular component positioning and leg length maybe improved by navigation, but most important is not to harm soft tissues and to be able to perform more perfect surgery with minimally invasive techniques in total hip arthroplasty.

Therefore we have focused in this book on minimally invasive surgery and the approaches and have tried to support the surgeons with a better understanding of these improved but also more difficult techniques.

The minimally invasive approaches described in this book can be adopted using different implants, but in the everyday practice, we have learned that not the socket side, but the stem side may be complicated and made more difficult when using large long stem implants or hip resurfacing techniques.

The best for the soft tissue is definitely a short stem, which can easily be implanted also in patients with very big muscles or morbid obesity. So, if the short stems can show in the long run that their results are as good as those of the other implants, this will probably be the implant of the future in minimally invasive total hip arthroplasty.

The trend in central Europe is not hip resurfacing (Germany 2,2% of all total hip arthroplasties) (2008, BQS (National Institute for Quality in Health Care, Duesseldorf/Germany) which is a very low number compared to the other procedures and the trend seems to be to use more cementless implantations than cemented (64,7% cementless, BQS 2008).

We see a clear trend to less invasive soft-tissue protecting procedures and maybe special implants, which facilitate the application of these minimally invasive approaches easier.

Especially with the minimally invasive approaches, we hope to realize the benefits of minimally invasive total hip arthroplasty, which are reduced postoperative pain, reduced blood loss, quicker recovery, shorter hospital stay, reduced hospital associate costs, faster return to normal activity, improved clinical outcomes, improved scar appearance, and greater patient satisfaction.

The editors think that these benefits are worth the effort together with minimally invasive approaches in total hip arthroplasty.

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