
Surgical Approaches to the Knee

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Contents

Introduction	2746
Medial Parapatellar Approach	2746
Advantage	2746
Disadvantage	2746
Technique	2746
Median (Midline) Approach	2747
Advantage	2747
Disadvantage	2747
Technique	2747
Y-Shaped Approach: “Mercedes-Benz Star”	
Approach	2747
Advantage	2747
Disadvantage	2748
Technique	2748
Lateral Parapatellar Approach	2748
Advantage	2748
Disadvantage	2749
Technique	2749
Posteromedial Approach	2749
Advantage	2749
Disadvantage	2750
Technique	2750
Posterior Approach	2750
Advantage	2750
Disadvantage	2750
Technique	2751
Minimally-Invasive Knee Surgery	2752
References	2752

Abstract

A thorough knowledge of the anatomy and biomechanics of the knee joint is the key factor for performing surgical procedures successfully.

The following seven basic principles should be kept in mind:

- Think before you cut!
- Respect the patient’s anatomy – split layers in line with fibres.
- Do not make dissections in the subcutaneous layer; go down to the subfascial layers.
- The incision/approach should be as big as necessary and as small as possible.
- Minimally-invasive approach does not necessarily mean a small skin incision. The incision should provide the surgeon with a sufficient exposure of the knee and enable him to safely and correctly perform the surgery.
- Think about further surgeries – you may not be the last surgeon operating on this knee joint.
- Take care to preserve the infrapatellar branch of the saphenous nerve and the blood supply of the patella.

The most commonly-used and well-established approaches to the knee joint are described in this chapter. The indications, advantages, disadvantages, risks and pitfalls of these different approaches are highlighted. A more detailed description of each approach is also given in the original articles, which are listed in the reference section.

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Introduction

In the early days of knee surgery knee surgeons strived to identify the optimal surgical approach to the knee, to the distal femur, to the proximal tibia and peri-articular structures. An optimal approach should not only allow easy access to the anatomical structures, but also to respect the functional anatomy. A sound understanding of the knee's anatomy is essential to obtain safe and reliable approaches to the knee [1].

It is a general consensus that there is no single best approach. The orthopaedic surgeon should be aware of a variety of several approaches, consider the correct indications and make the right choice for every clinical scenario.

As the knee is very sensitive to disruption of its proprioception one of the most important questions is obviously where to make the skin incision. Regardless of the skin incision, any arthrotomy, meaning the incision of the underlying joint capsule, may be performed either laterally, medially, as a medial split (as described by Insall) or as a medial subvastus ("Southern") approach [2–5].

In the last decades many authors focussed on minimally-invasive approaches to the knee joint. However, the question if minimally-invasive approaches lead to better clinical results than "classic" approaches, remains still under debate.

We describe some of the most commonly-used open approaches to the knee joint, which have proven to be effective in the hands of the authors.

Medial Parapatellar Approach

This classic workhorse approach is the most commonly performed approach to the knee joint [6, 7]. It is frequently used for total knee arthroplasty.

Advantage

This approach allows good exposure of the medial side of the knee. It can easily be extended both proximally and distally and hence it allows easy access to both the medial and lateral compartments.

Disadvantage

The greatest disadvantage of this approach is the substantial risk of injury to the infrapatellar branch of the saphenous nerve. The nerve runs posterior to the sartorius muscle, goes through the fascia between the tendons of the sartorius and gracilis muscles and then becomes subcutaneous on the medial side. The infrapatellar branch supplies the skin of the medial side of the knee. Injury to this branch may lead to the development of a post-operative neuroma. It may compromise subjective and objective function of the joint, e.g. of even the most perfectly aligned total knee arthroplasty.

The overview of some aspects of the knee joint, especially laterally, may be limited with this approach, so it may sometimes be necessary to add another skin incision and arthrotomy (e.g. in open reconstructive ligament surgery). In valgus knees of more than 20° the medial parapatellar approach may not be recommended since a mandatory lateral release could hardly be performed from medially. In very tight knees one should be very cautious not to partially or fully detach the patellar ligament, which is difficult to re-attach and generally results in a catastrophic functional result. Careful closure of the medial capsular incision is mandatory in order to allow good patellar alignment.

Technique

The longitudinal incision begins at the medial border of the quadriceps tendon, about 7–10 cm proximal to the patella. The incision is generally straight or slightly curved around the medial border of the patella and is then brought back towards the midline. We recommend to end

with the incision at or slightly distal to the tibial tuberosity. The subcutaneous tissues in the line of the skin incision are divided under meticulous haemostasis. The fascia is then divided and retracted and the dissection deepened. A deep incision is made between the vastus medialis muscle and the quadriceps tendon and the joint is entered. A small flap of soft tissue (capsule, retinaculum) should be left attached to the patella in order to allow for repair of the capsule after the procedure has been completed. The patella may then be retracted laterally, with or without eversion of it. The fat pad is either retracted or resected as needed.

If more exposure is needed, this may be obtained by subperiosteal elevation of the medial part of the patellar tendon, leaving it in continuity with the distal periosteal fibres. Proximal extension of the approach may be established along the lateral border of the vastus medialis muscle within the quadriceps tendon.

An alternative proposed by some authors, is the so-called “subvastus” approach [8, 9]. The main part of the medial patellar vessels (the articular branch of the descending artery) is preserved, and the proponents of this approach also state that the infrapatellar branch of the saphenous nerve is less endangered by the skin incision [10, 11].

Median (Midline) Approach

This approach combines the advantages and disadvantages of the medial parapatellar approach, using a skin incision which lies in the midline over the patella and the tibial tuberosity. It has gained popularity for total knee arthroplasty, since a small skin incision can be combined with a lower risk of injury to the infrapatellar branch of the saphenous nerve [12, 13].

Advantage

In general, there are the same advantages as with the use of the medial parapatellar approach. Extension proximally and/or distally is possible. The surgeon can either perform a medial or a lateral

arthrotomy. The skin incision can be rather small, which is one of the reasons this approach has become so popular for total knee arthroplasty.

Disadvantage

The major disadvantage of this approach lies in an increased risk of wound healing problems [14–16]. The incision lies on the “ridge” of the bony underlying structures and will be under tension medially as well as laterally. This may compromise proper wound healing, especially in the obese patient. Injury to branches of the infrapatellar part of the saphenous nerve cannot be completely avoided with this approach. The blood supply to the patella is also under risk to be compromised.

Technique

A straight skin incision is performed, which begins 4–5 cm proximal to the patella, and extends to the tibial tuberosity. After careful medial and very limited lateral subcutaneous dissection, the procedure may be continued as described above in the section on the medial approach. Care should be taken when releasing the insertion of the patellar tendon in tight osteoarthritic knees of obese patients.

Y-Shaped Approach: “Mercedes-Benz Star” Approach

In our clinical practice we unfortunately still see patients having undergone this approach, especially in open reduction and internal fixation of fractures. This approach is very risky and should be abandoned due to its high probability of wound healing problems. A standard straight lateral approach provides good exposure in fractures of the tibial head at a much lower risk of complications.

Advantage

This approach provides an excellent exposure to the anterior part of the knee [17], especially

in comminuted proximal tibial fractures. With osteotomy of the tibial tubercle and retraction of the extensor or flexor apparatus, one obtains an excellent exposure of the anterior compartment.

Disadvantage

This approach is extremely prone to severe wound healing problems, which include skin necrosis, excessive scarring and infection. When considering these potential complications, we do not see any benefit over other approaches in terms of exposure and /or soft tissue handling.

Technique

Due to the fact that we do not encourage using this approach and since a lateral parapatellar approach (with osteotomy of the tibial tuberosity) gives the same good exposure, the method will not be described.

Lateral Parapatellar Approach

Although already described in the late 1950s, this approach has not yet become very popular [13, 18]. It gives a limited exposure to the anterior aspect of the knee and its uses were initially restricted to identifying loose bodies, lateral meniscal problems and intra-articular fractures. However, it has received increased interest in recent years. When combined with a carefully performed osteotomy of the tibial tubercle (see below) his approach can be very helpful in TKA. The precarious vascularity of the patella can be preserved [6, 14, 18–23] and one gets an excellent view of the knee ('open book'). In revision surgery it does offer wide exposure including the lateral release without compromising the patellar tendon (Fig. 1).

Advantage

The approach preserves much of the vascularity of the patella and does not interfere with the

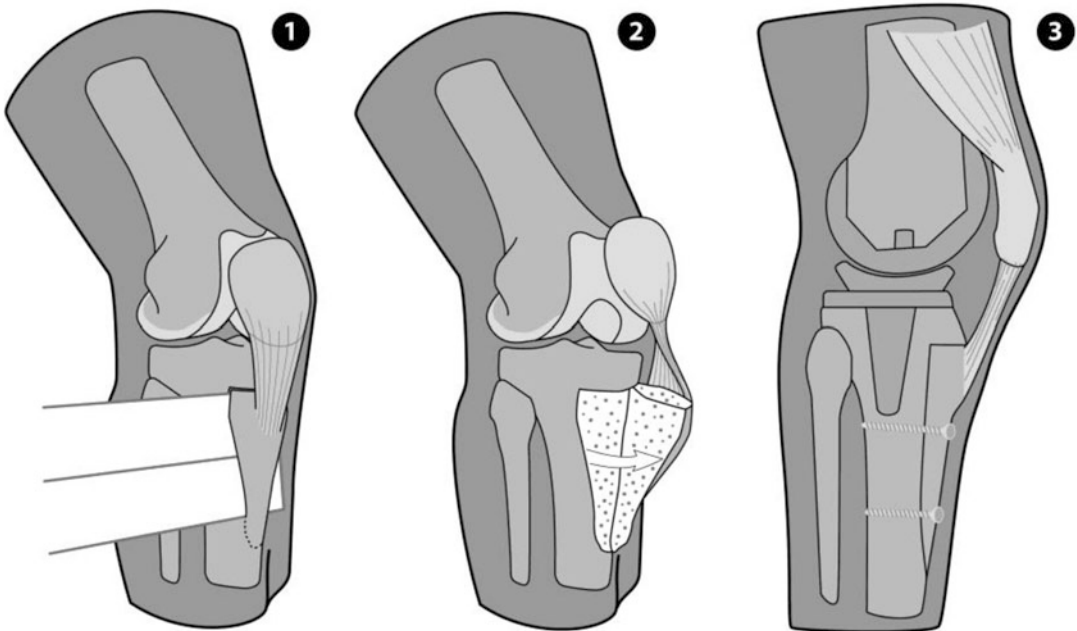


Fig. 1 Lateral parapatellar approach with tibial tubercle osteotomy in step-cut technique

infrapatellar branch of the saphenous nerve. In combination with the tubercle osteotomy, an excellent exposure of the knee can be obtained without causing any harm to the patellar tendon itself. The exposure of the lateral as well as the medial side is excellent. Any extension in proximal and distal directions is easily feasible. In the event of multi-ligament knee reconstruction, most compartments can be reached with this one incision. The lateral retinacular release is “included” in the approach, which is helpful when addressing a tight valgus fixed knee in total knee arthroplasty.

Disadvantage

One of the major disadvantages of this approach is the fact that a longer skin incision is usually necessary, especially when compared with the straight midline approach. In order to avoid any complications with skin flaps, care has to be taken to carry out subfascial and not only subcutaneous dissections. An osteotomy of the tibial tuberosity may be required, which may be related to specific complications such as displacement of the tibial tubercle fragment.

Technique

The incision is made parapatellar and laterally. The skin should be incised about 2 cm lateral to the patella and should be straight and not curvilinear (as shown in too many textbooks). Curvilinear incisions are prone to local wound healing problems [11]. After skin incision, the deep fascia has to be identified. The iliotibial tract is divided parallel to its fibres down to Gerdy’s tubercle. A (lateral) subvastus approach to the knee joint can then be done. This lateral subvastus approach can even be extended up to the hip, if necessary. However, in this case, the arteries and veins must be identified and carefully ligated [15].

The lateral approach usually allows easy and safe approach to the popliteus muscle and the insertion of the lateral collateral

ligament (after incision of the iliotibial tract). By dividing the layers between the iliotibial tract and the biceps femoris brevis, one reaches the lateral meniscus, the popliteus muscle, the lateral gastrocnemius as well as the insertion of the biceps femoris tendon at the fibular head. Lesions of these structures in acute knee injuries are not rarely encountered. In fact, an osteotomy of the tibial tuberosity seems to be the anatomically “logical” continuation of the lateral approach. However, the tuberosity has to be osteotomised in such a fashion that there is no possible disruption of the extensor mechanism and no proximalisation (Fig. 1). Hence, a very good exposure of the knee joint (“open book”) is obtained [24]. The osteotomy of the tuberosity may be considered risky [25, 26]. However, the patellar tendon is preserved and will not be compromised during the operative procedure. After implantation of total knee components, the incision is closed in layers. This should be done preferably in 90° of knee flexion to obtain a balanced patellar tracking. Since the lateral approach “includes” a lateral release, this approach is particularly useful in complex, rigidly fixed valgus knees.

Posteromedial Approach

This approach provides excellent access to the posterior horn of the medial meniscus. It may also be useful in arthroscopically-assisted meniscal suture using the inside-out technique, where the retrieval of the needles is facilitated. The approach also allows repair of the posterior capsule and the posterior aspect of the medial collateral ligament (posterior oblique ligament of the medial collateral ligament) or capsular release in knee extension deficits in (post-traumatic) arthrofibrosis [27] (Fig. 2).

Advantage

This approach provides easy access to the posterior capsule and the posterior aspects of the medial collateral ligament.

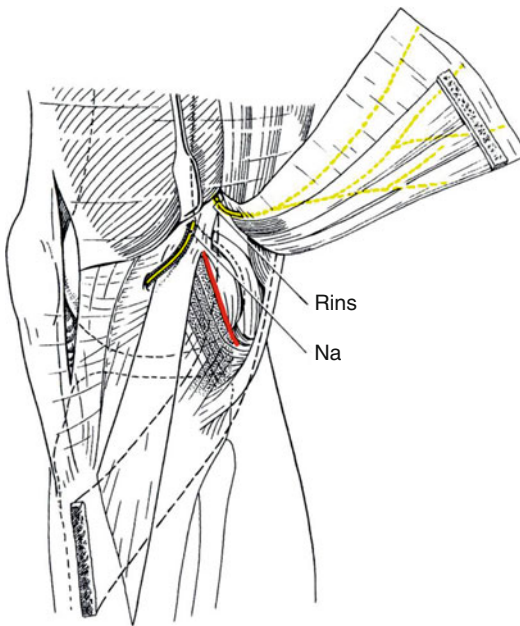


Fig. 2 Posteromedial approach (Adapted from Werner Müller, 1982 [14])

Disadvantage

Visualisation of the posterior cruciate ligament and the most posterior aspects of the knee can be impaired by the thick joint capsule. Too much dissection may lead to vascular compromise, as well as soft tissue and skin healing problems.

Technique

Place the patient supine and externally rotate the hip as much as possible. A sandbag or leg holder may be used. Flex the knee between 30 and 45°. The skin incision follows a slight curve from the adductor tubercle to the posterior margin of the tibia. The sartorius muscle may be taken as a reference. After the anterior margin of the sartorius is defined, it can be retracted posteriorly, thus preserving and protecting the saphenous nerve. The underlying medial collateral ligament is now exposed. By retracting the hamstring muscles, which are lax at this knee flexion angle, the posterior aspect,

the medial femoral condyle and the posterior aspect of the medial meniscus are defined. Upward mobilisation of the meniscus allows inspection of the medial tibial plateau.

Posterior Approach

This is the “classic” posterior open approach to the knee, as described by Hughston [12] and Henderson, and later by Trickey et al. [28]. Due to the success of arthroscopic surgery this approach has been less frequently used in recent years. Due to the proximity of the neurovascular structures Orthopaedic surgeons hesitate to use this approach. However, for open resection of Baker’s cysts as well as for open sutures or reconstructions of the posterior cruciate ligament, this approach is still very useful. To avoid the associated extensive soft tissue dissection necessary for the “classical” approach as described by Hughston, Henderson and Trickey, adaptations and modifications have been advocated. With Burks’ modification, much less soft tissue dissection is needed and in most cases access of the posterior capsular structure is more than adequate. Nicandri et al. [29] described a modified open posterior approach to fix the avulsed PCL fracture, with similar exposure as the classical posterior approach, which necessitates the identification of the popliteal neurovascular elements (Fig. 3).

Advantage

Especially when utilising the simplified approach as described by Burks et al. [30], easy access to the tibial attachment of the posterior cruciate ligament is gained, which facilitates the so-called “on-lay” technique of PCL reconstruction with auto- or allografts, shown in biomechanical testing to be superior to arthroscopically- assisted techniques. In addition, Baker’s cysts can be excised easily.

Disadvantage

The “traditional” approach as described by Trickey may compromise vessels (popliteal artery)

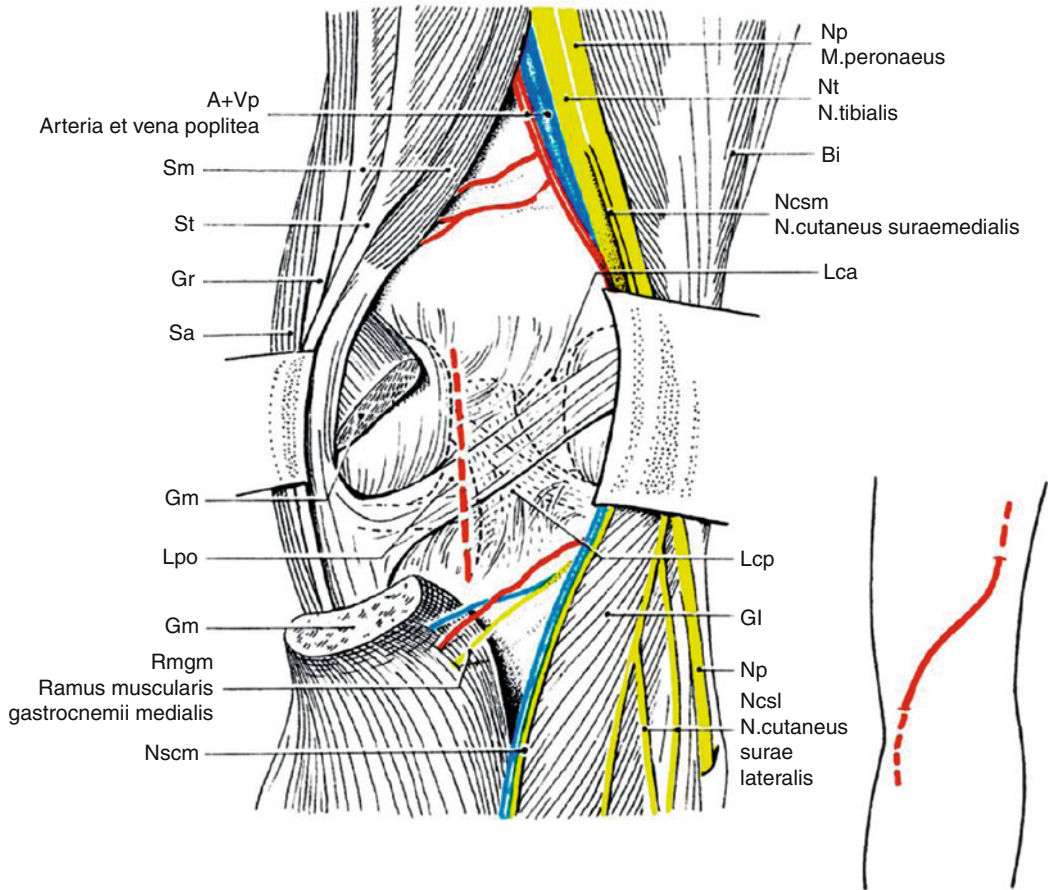


Fig. 3 Posterior approach (Adapted from Werner Müller, 1982 [14])

and neurological structures (medial sural cutaneous nerve, tibial nerve, common peroneal nerve) in the popliteal fossa of the knee, causing damage to those structures, especially when performed by inexperienced surgeons.

The patient must be positioned prone, which not all patients undergoing procedures with regional anaesthesia find comfortable. If the patient receives general anaesthesia, the surgeon should make sure that the patient is placed correctly, avoiding any further positional damage to nerves or joints.

Technique

Place the patient prone on the operating table. A curved “lazy S” incision is made, beginning

proximally on the medial side of the knee joint. Proximally, the incision runs along the semimembranosus muscle, turns transversely at the knee joint level and extends distally parallel to the lateral head of the gastrocnemius muscle.

In the modification proposed by Burks et al. [30], the incision is placed medially so that it lies between the semimembranosus muscle and the medial head of the gastrocnemius. In the classical Hughston/ Henderson/ Trickey approach, the sural nerve between the two heads of the gastrocnemius muscle must be defined. After incision of the popliteal aponeurosis, the tibial nerve, the common peroneal nerve and its branches must be identified and released. They are retracted to the lateral side. Incision of the medial head of the gastrocnemius muscle to gain

better access, as originally described, may be avoided by gently flexing the knee joint. In Burks' adaptation, the neurovascular structures do not need to be identified at all. By retracting the medial head of the gastrocnemius muscle laterally, these structures are protected by the muscle belly.

Minimally-Invasive Knee Surgery

Minimally-invasive total knee arthroplasty has generated great interest from patients, surgeons, and health-care providers. The meaning of minimal invasiveness is more than just providing the patient with a smaller and less noticeable, more cosmetically appealing surgical incision. Minimally-invasive surgery aims for only minimal interruption of nervous tissue and vascular supply, minimal dissection of muscles, tendons, and ligaments, minimal resection of bone, minimal loss of blood and minimal post-operative pain to the patient (Fig. 4).

Five different approaches namely the mini-medial parapatellar, quadriceps muscle sparing, mini-midvastus, mini-subvastus and direct lateral approach were reported. All these approaches aim to decrease the post-operative pain, to ease early ambulation and to shorten the recovery period for the patient.

However, many authors reported rather high rates of adverse events and a slow learning curve for the surgeon. With a limited exposure, the skin, capsular tissues, and bone surfaces might receive higher stresses because of the greater retraction required.

The five above-mentioned approaches mainly differ in the degree to which the proximal arthrotomy is performed. The mini-medial parapatellar and direct lateral approach perform a shorter proximal arthrotomy than the standard approaches.

The quadriceps muscle-sparing, the mini-midvastus and mini-subvastus approach always end at the proximal pole of the patella.

To date, there also is a lack of long-term results. Moreover, these techniques are certainly

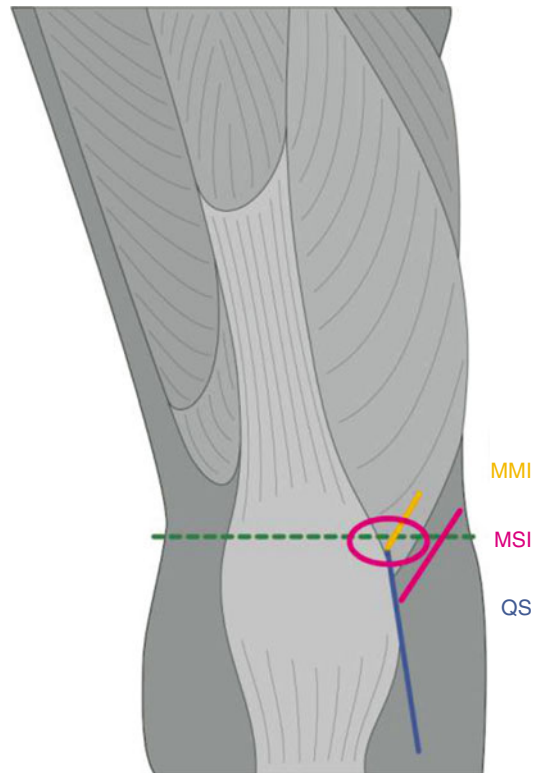


Fig. 4 Minimal-invasive approaches (mini-medial parapatellar, quadriceps muscle sparing (*QS*), mini-midvastus (*MMI*) and mini-subvastus (*MSI*))

not for all patients or all doctors, and the indications are still to be identified.

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