CURRENT CONCEPT REVIEW

Systematic Analysis of Painful Total Knee Prosthesis, a Diagnostic Algorithm

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Abstract

Remaining pain after total knee arthroplasty (TKA) is a common observation in about 20% of postoperative patients; where in about 60% of these knees require early revision surgery within five years. Obvious causes of this pain could be identified simply with clinical examinations and standard radiographs. However, unexplained painful TKA still remains a challenge for the surgeon. The management should include a multidisciplinary approach to the patient`s pain as well as addressing the underlying etiology. There are a number of extrinsic (tendinopathy, hip, ankle, spine, CRPS and so on) and intrinsic (infection, instability, malalignment, wear and so on) causes of painful knee replacement. On average, diagnosis takes more than 12 months and patients become very dissatisfied and some of them even acquire psychological problems. Hence, a systematic diagnostic algorithm might be helpful. This review article aims to act as a guide to the evaluation of patients with painful TKA described in 10 different steps. Furthermore, the preliminary results of a series of 100 consecutive cases will be discussed. Revision surgery was performed only in those cases with clear failure mechanism.

Keywords: Diagnostic algorithm, Failure analysis, Pain, Total knee arthroplasty

Introduction

Treatment of patients with osteoarthritis of the knee using total knee arthroplasty (TKA) usually leads to a significant improvement in quality of life. Evaluation of prosthetic registries and other meta-analysis reflect this. These representative collectives show a satisfaction rate of 80 to 85% after this operation and the number of performed TKAs is continuously increasing in the population. However, what happens to patients who are less or not satisfied with their TKA?

Evaluation of painful TKAs is a great challenge even for the knee surgeon. Cause analysis of failure requires experience in primary and revision arthroplasty and a profound knowledge of various prosthetic designs with their biomechanical concepts and different implantation strategies. During the last decade a specific diagnostic algorithm for painful TKA had been developed. The aim of this paper is to describe a detailed algorithm in order to analyze patients suffering from painful TKA. Furthermore, a study will be presented, where in 100 consecutive patients with painful TKA will be explored by using this algorithm and then treated accordingly.

Diagnostic algorithm

1. Extended history
2. Type of pain analysis
3. Psychological exploration
4. Clinical exploration
5. Infiltration
6. Laboratory tests
7. Aspiration
8. Radiographs
9. Special imaging
10. Therapeutic trial

1. History before and after TKA

In order to do a chronological evaluation of the complete medical history all previous surgical reports, imaging (X-ray, CT, MRI before surgery, scintigraphy, and ultrasound) and laboratory tests (blood serology and bacteriology of aspirates) have to be processed. In particular, previous surgeries on the affected joint with complications and comorbidities such as diabetes mellitus, rheumatoid arthritis, psoriasis, and immunosuppression play an important role. Also, the knowledge of the type of the implanted prosthesis with its system-specific biomechanics and the associated advantages and disadvantages allows conclusions on the present pain or discomfort. Furthermore, a precise social, recreational and occupational history is important to evaluate if these facts can be related to the complaints (high activity level and expectations, desire for retirement, recent separation from partner, secondary gain of disease or current psychological consultations, and so on).

2. Types of pain

The most important symptom in the majority of the cas-

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Table 1. Types of pain

Type of pain	Possible reason(s) for failure
Pain at night and rest	Infection Joint effusion or neurogenic related
Starting pain	Loose components
Weight-bearing pain	Unspecific Mainly mechanical cause, Infection
Pain on full extension	Anterior soft tissue impingement Posterior tightness, posterior osteophytes, flexion-/extension gap mismatch
Pain on full flexion	Post impingement (offset/osteophytes) Patella impingement or tightness, malrotation
Pain on descending Stairs and chair raising	Flexion gap instability Femur malrotation

es is pain, while to a lesser degree is restriction of movement, instability or swelling. Time, onset, location, quality and reproducibility of pain should be analyzed and could even allow some preliminary conclusions to the cause of failure. Furthermore, the type of pain before the primary TKA should be compared to the type of postoperative pain. The reasons for presenting pain in the early postoperative period are usually an acute infection, instability due to inadequate soft tissue balancing, prosthesis misplacement and soft tissue impingement. Reasons for later onset of pain may be loosening, polyethylene wear, ligamentous instability, a late infection or stress fracture. The precise anatomical localization of the painful area(s) might be helpful in the analysis of the primary problem. Six characteristic types of pain can be differentiated (Table 1).

There are lots of rare causes that should be considered, such as electrifying pain with superficial contact (e.g., bedding) indicates a cutaneous neuroma. Sudden shooting pains by changing position have mostly mechanical causes like soft tissue impingement. With radiating pain or same discomfort preoperative an extra-articular etiology (hip, lumbar spine, vascular cause, and so on) should be considered.

3. Psychological exploration

Patients with persistent pain over six months are classified as chronic pain patients who need to have psychological care. If there is a history of any psychological diseases then the patient should initially receive an interdisciplinary treatment together with clinical psychologists. It is important to know whether psychogenic factors are projected somatically. In such cases revision should not be continued.

4. Physical examination

The exploration of the knee joint should include active and passive range of motion, swelling state (extra- and intra-articularly), stability [varus and valgus stress in extension (30°) and flexion (90°), flexion-extension gap ratio and anteroposterior stability], scars, skin changes, signs of infection, patellar tracking, extensor mechanism and trigger points. Swelling may be associated with a recurrent hemarthrosis (incidence 0.3 to 1.6%) that is caused by proliferative synovitis, PVNS or coagulation disorders including hemophilia (1). Atrophic, doughy skin with painful functional limitation of the joint indicates chronic regional pain syndrome (CRPS). Selective pressure on painful soft-tissue is usually caused by irritation of the corresponding structures, such as impingement of the medial collateral ligament, pes anserinus, the popliteus tendon or the iliotibial tract by protruding prosthetic components (2, 3). If there is a palpable and painful pinching of soft tissues in the patellofemoral joint in extension with the PS prosthesis, it is called patella clunk syndrome. The exploration of the lumbar spine, the hip, the ankle and the foot, as well as a neurovascular status, should be included in the analysis of painful TKA. In particular, radicular pain has to be distinguished from referral pain. Pain from osteoarthritis of the hip joint can be projected to the implanted TKA.

5. Infiltration

The infiltration of painful tender points on the knee joint using local anesthetic is used to assign anatomical structures. For example, if infiltration of the medial collateral ligament leads to loss of symptoms, an intra-articular cause like infection, polyethylene wear or loosening is unlikely and impingement with a protruding tibial component or an overload of the medial collateral ligament by impaired biomechanics is rather likely. If CRPS is suspected as a result of clinical and radiological exploration, a diagnostic sympathetic blockade may be useful. Infiltration of the iliosacral joint or nerve radix blockade can distinguish knee pain from spinal origin. Following an aspiration, a local anesthetic should be injected intra-articularly if the fluid does not macroscopically present any typical signs of infection. This has mainly diagnostic value and may give evidence to differentiate between intra- and extra-articular causes. Moreover, if secondary gain of disease is suspected the injection of a placebo can offer further information.

6. Laboratory tests

The erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) are routinely used for infection clarification. The ESR peak is 5-7 days after surgery and returns after three months to baseline (4). CRP, due to its higher sensitivity, is a better indicator with its peak 2-3 days after surgery and returns after about three weeks to baseline. With a combination of elevated CRP and elevated ESR a sensitivity of 0.95, specificity of 0.93 and a negative predictive value of 0.97 are specified (5). The serum levels of interleukin 6 (IL-6) play a more important role for the early postoperative period, since it covers an area by a rapid rise and fall (baseline after 48 to 72 hours), in which ESR and CRP could be normal. The combination of IL-6 and CRP shows a high sensitivity (6). Patients with a positive history of allergy require a corresponding dermatological exploration. The clinical relevance according to current knowledge is small (7).

7. Aspiration

Testing synovial fluid is mandatory for suspected infection (8). Routinely, leukocytes are counted and bacteriological tests for aerobes and anaerobes should be cultured. Antibiotic therapy should be stopped at least two weeks before a planned aspiration. Additionally, it should be performed without local anesthetics under sterile conditions. The Gram stain has low sensitivity and specificity (9). A leukocyte count above 2500/mm and about 60%

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Figure 1. Patella dislocation due to internal malrotation of femoral and tibial component in skyline view.

polymorphonuclear leukocytes show a high sensitivity and specificity for infection, but limits for pathology in the literature are different (3, 10-13). Positive culture findings must always be compared with the clinical symptoms and serological tests. In case of suspected contamination, the aspiration has to be repeated. Before a surgery, because of the probability of late infection, there should be at least three aspirations performed or the histological test of a tissue should be additionally obtained arthroscopically. For exploration of a suspicious infection in TKA, Parvizi *et al* elaborated on a diagnostic algorithm for infected TKAs (13).

8. Radiographic analysis

A full leg x-ray, a lateral x-ray and an axial patella view, performed under load (weight bearing view) is the standard to evaluate a painful TKA and presents the following information: type of prosthesis, leg alignment, position of components in the sagittal plane, component size and overhang, loosening, osteolysis, polyethylene abrasion, joint space asymmetry (except for the Journey ®, Smith & Nephew, asymmetric inlay 3° prosthesis types), stress fracture, heterotopic ossification, inadequate patella cut or patella shift, tilt or (sub)luxation (Figure 1). If there are preoperative radiographs for comparison available, state-

Figure 3a. Standard ap-view with suspect step in femoral component.

Figure 2a. TKA with significantly reduced posterior femoral offset.

Figure 2b. Reference for posterior femoral offset is preoperative ipsilateral or contralateral x-ray.

ments about joint lines, posterior femoral offset (Figure 2a), absolute or relative patella alta or baja can be made. If these images are not available, then it is useful to compare the contralateral side, if it has not yet been replaced (Figure 2b).

For specific questions fluoroscopic controlled views are suitable. Prosthetic fractures (Figure 3a, b) or loosening lines can be better identified by precise adjustment of the prosthesis-bone-interface. Stress images can show flexion or extension gap instabilities and give an indirect indication of the femoral component malrotation (14).

9. Special imaging

Scintigraphy should be used as a tool of diagnosis con-

Figure 3b. Same prosthesis as shown in figure 3a showing breakage of femoral component due to osteolysis and loss of bone support in the medial femoral condyle shown under fluoroscopy controlled view.

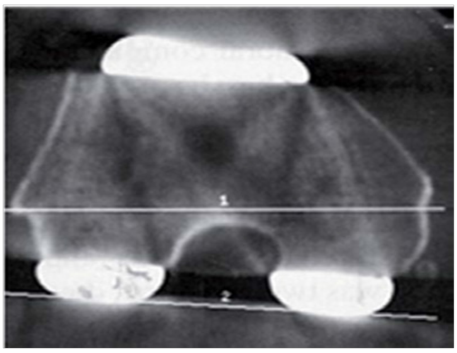

Figure 4. Internal rotation of femoral component compared to surgical epicondylar line shown in CT.

firmation and not as a screening tool. If there is concrete evidence of loosening or overloaded prosthesis-bone-interface, then conducting a Technetium-99m scintigraphy makes sense. The sensitivity of this test is high and the specificity low, but with negative results, loosening or infection can be widely eliminated Because of physiological bone remodeling after implantation doing this test is not practical before one year postoperative (15, 16). An increased accumulation in all three phases is shown, for example in infection, but can also occur in osteolysis due to polyethylene abrasion.

Computed tomography (CT) should be used when periprosthetic fissures or malrotation of the tibial or femoral component are suspected.Only CT scans can be used to determine the rotational position, which were made according to a specific protocol (17) (Figure 4).

10. Conservative therapeutic trial

If no clear cause of failure can be verified, a conservative therapeutic trial should be done. This should take at least three months and include analgetic therapy, support through technical orthopedic aids and adequate physiotherapy. Reasons for pain can be muscular overload on the one hand and atrophy on the other hand, which should be addressed accordingly.

Our Study

The aim of this retrospective study was to analyze the failure cause(s) of 100 consecutive patients from 1999 to 2003, who had a TKA -revision surgery. Sixty-nine women and 31 men with an average age of 65 years (range: 33-83 years) and a mean follow-up of 16 months (range: 13-25 months) participated in this study. The time between revision and primary implantation and the clinical outcome after revision was evaluated by established scores (HSS). In the revision surgery, the situation was re-evaluated and corrected, taking into account the preoperative analysis.

Results

In 48% of cases malalignment (>4°) caused overload, pain and/or polyethylene wear. In 26% of cases malrotation of the tibia or femur component was the reason for patella maltracking, stiff knee or instability in the flexion gap. Instability in extension, midflexion and full flexion comprised of 23% of the reasons for pain. In 19% of the cases there was an early or late infection, and in 24% various other rare causes were identified. Only in 9% an aseptic implant loosening without deviation occurred. In 54% of revision surgeries a combination of several causes were determined. Seventy-eight percent of these revisions were performed within three years after primary implantation and in 89% incorrect implantation could be blamed for the prosthetic implant failure. The clinical outcome was assessed with the Hospital for Special Surgery score (HSS) and could be increased from a preoperative average of 64 (50-71) points to 84 (58 to 93) points. Finally, 32 patients estimated their situation after the revision as very good, 46 as good, 15 satisfying and 7 as bad.

Patients with painful TKA often lose their quality of life, so they should be explored systematically. The obvious reasons are unfortunately rare; there is often a concatenation of "small" mistakes which lead to failure of the prosthesis. Understanding all the cause(s) of failure(s) in painful TKAs is important before performing any revision surgery. Vince had pointed out that revision surgery should always correct all failures otherwise there is a high risk to simply "repeat surgery" and make the same mistakes again (18). In this article, the concept of a step-by-step diagnostic algorithm is described in more detail for painful TKAs. By using this diagnostic algorithm in almost all cases, a sufficient failure analysis is possible, which is the prerequisite for a successful revision surgery in patients with painful TKA. An interdisciplinary intervention by surgeons, pain specialists, physical therapists and psychologists is helpful. Nevertheless, there will always be cases in which, according to current knowledge no cause for the pain can be found. Brander *et al* reported that 13% of the patients after TKA had unexplained pain one year postoperatively. After a follow-up of five years, all patients were free of pain with conservative therapy (19, 20). Furthermore, if no reason for the painful TKA is found, no revision surgery should be performed.

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