

# PAIN FOLLOWING TOTAL KNEE ARTHROPLASTY – A SYSTEMATIC APPROACH

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## ABSTRACT

Total knee arthroplasty (TKA) is known to be a successful procedure. The aging of the population and the growing demand for quality of life have greatly increased the indications for the procedure. Nonetheless, TKA presents some complications that still lack definitive resolution. Pain after TKA is caused by a myriad of reasons that need to be systematically

studied in order to reach the correct diagnosis and treatment. History, physical examination, laboratory tests and imaging examinations must all be included in the workup and repeated until a plausible reason has been identified, since if pain is the only indication for TKA revision, the results may be catastrophic.

**Keywords** – Arthroplasty, total knee; Diagnosis

## INTRODUCTION

Total knee arthroplasty (TKA) is a very successful form of treatment for degenerative abnormalities of the knee. The demand for TKA is growing around the world because of the aging of the population and the need to preserve people's quality of life. However, after one in every 300 knee arthroplasties, pain without any known explanation will be presented(1). The pain may occur either at rest or with movement. The knee may have a good range of motion, and objective evaluation on the prosthesis may show a perfect result, with good positioning of the implants seen on radiographs, yet the patient complains of pain. Adequate assessment of this condition is important for orthopedists who carry out TKA. It is important to bear in mind that if TKA revision is indicated without a precise diagnosis, it will be successful in only 17% of the cases, and that even if an abnormality is found and corrected during the operation, the revision will only have good results in 25% of the cases(2). Evaluation of a painful total prosthesis should involve four important points, in order to identify the precise etiology: clinical evaluation, laboratory

investigation, imaging assessment and microbiological analysis. Even when all these stages are carried out, a diagnosis is not always achieved. For this reason, it is important to establish a systematic approach that would make it possible to repeat the diagnostic process until reaching an adequate conclusion and only thereafter to indicate treatment.

## Causes of pain in TKA

The first point to be assessed is the likely origin of the pain. To facilitate the investigation, the possible causes can be divided into joint and non-joint types. The two groups are listed below.

### 1. Joint-related causes

- a. Loosening of implant
- b. Instability
- c. Failure of a component
- d. Infection
- e. Femoropatellar problems
- f. Synovial pinching

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- g. Osteolysis: synovitis or microfracture
- h. Other causes:
  - 1 - Patellar clunk syndrome
  - 2 - Irritation of the lateral facet of the patella
  - 3 - Dysfunction of the tendon of the popliteal muscle
  - 4 - Protuberance of tibial component on medial side

## 2. Non-joint causes

- a. Neurological disease
- b. Hip disease: osteoarthritis, avascular necrosis, fracturing due to failure of the subchondral bone in the femoral head
- c. Vascular disease: arterial insufficiency, aneurysm, thrombosis
- d. Reflex sympathetic dystrophy
- e. Soft-tissue irritation: tendinitis, bursitis, neuroma
- f. Other diseases: Paget's disease, pigmented villonodular synovitis, rheumatoid arthritis and ankle and foot diseases
- f. Psychological factors

## Evaluation of patients with pain after TKA

- 1 - Clinical history and physical examination
- 2 - Laboratory evaluation
- 3 - Imaging evaluation

## CLINICAL HISTORY

The history of the pain is of very great importance to the investigation. To facilitate the investigation on the history of the pain, it is recommended that it should be structured:

**1 - Location and irradiation of the pain:** palpation of the periarticular structures is important for identifying neuromas and problems with the size and implantation of the prosthesis.

**2 - Length of time for which the symptoms have been present:** The type of pain present, compared with the preoperative pain, provides important information. If the pain is the same as it was initially, it is most likely that the cause is extra-articular and, for this reason, arthroplasty will not resolve the symptoms. Hip diseases such as avascular necrosis of the femoral head, osteoarthritis and fracturing due to failure of the subchondral bone may provoke symptoms in the knee because of irritation of the obturator nerve. Vascular problems such as arterial insufficiency with intermittent claudication, arterial aneurysm and thrombosis are causes of knee pain. A history of diabetes with the presence of peri-

pheral neuropathy may cause pain in the lower limbs associated with paresthesia. Patients with a history of diabetes, psoriasis, rheumatoid arthritis or other conditions that cause immunodepression are more likely to develop infections.

**3 - When the pain appeared:** Patients with persistent pain starting in the immediate postoperative period, without any history of improvement, should be investigated for acute infection, instability of the prosthesis, misalignment and non-joint causes. In patients with a substantial improvement in pain during the postoperative period who subsequently start to present pain again, the cause of the pain may be loosening of the components, late posterior instability (patients with prostheses that preserved the posterior cruciate ligament with late instability) or late infection through a hematogenic route<sup>(3)</sup>.

**4 - Improvement factors:** Reports of pain that appears with movement and improves with rest suggest that the origin is mechanical, compatible with loosening of components or degenerative disease in the hip. Continuous pain points towards suspected inflammatory problems, of which infection is the most important.

**5 - Incapacity caused by pain:** Defining the degree of incapacity is also an important parameter for defining the cause of the pain. Patients who need some type of support to walk, such as crutches or a wheelchair, probably present mechanical causes, for example instability or loosening of components. When there is no correlation between function and pain intensity, the physician should suspect reflex sympathetic dystrophy.

## Physical examination

The physical examination is general, with emphasis on limb alignment, range of motion, presence of any joint edema or periarticular edema, condition of the femoropatellar joint (using palpation) and type of gait (Figure 1). Concomitant presence of heat, redness, swelling and pain leads to the idea of an acute inflammatory condition, and infection should be considered to be the first diagnostic hypothesis. However, this more explicit condition of infection is not the most frequent condition. The great problem is infections with few clinical manifestations, and notably only presenting pain.

Limb misalignment indicates problems with the alignment of the implant, which may be confirmed with imaging examinations. Clinical suspicion directs the radiological examination. The angle between the ante-

rior tuberosity of the tibia and the major axis of the foot is indicative of problems of rotational alignment of the tibial component.

Gait examination is fundamental for demonstrating possible instability. Asymmetrical rotation of the feet



**Figure 1** – Bilateral TKA showing adequate alignment and complete extension.

indicates that the tibial component was implanted with excessive internal or external rotation, which can be confirmed by means of computed tomography<sup>(3)</sup>.

Palpation of painful points around the joint helps to identify scar neuromas<sup>(4)</sup>, tendinitis and bursitis, such as those that occur in the pes anserinus<sup>(5)</sup> or femoral biceps<sup>(6)</sup>. Infiltration using local anesthetic is a simple method for defining these causes of pain. Pain in inter-line regions, especially the medial region, may be provoked by the protruding tibial component (Figure 2).

The passive and active range of motion should be analyzed to look for possible losses. A flexed attitude may be secondary to an error during the surgical procedure (space in tensed extension), joint effusion or even rupture of the extensor apparatus (injury to the quadriceps tendon or patellar ligament, or fracturing of the patella). Flexion deficits generally occur after arthroplasty procedures that preserve the posterior cruciate ligament, in which this presents excessive tension.

Examination of the femoropatellar joint may show possible misalignment or instability. Evaluation of the quadriceps muscle and the extensor mechanism is important with regard to joint function and pain genesis. Femoropatellar instability may be caused by a femoral component presenting internal rotation or a tibial component presenting excessive internal rotation<sup>(7)</sup>, or by excessive valgus alignment of the knee. It is difficult to



**Figure 2** – Tibial component showing protrusion in the medial compartment.

demonstrate rotational misalignment using simple radiographs, and it is often necessary to investigate further, through computed tomography<sup>(8)</sup>.

Evaluation of the vascular and neurological status is fundamental for ruling out pain problems relating to radicular compression, peripheral neuritis and vascular insufficiency.

When the pain is disproportional to function, a diagnosis of reflex sympathetic should be considered, which presents an incidence of 0.8% during the postoperative period following total knee arthroplasty<sup>(9)</sup>. The four commonest signs of this pathological condition are pain, edema, joint stiffness and changes to the shine and texture of the skin. Pain is the symptom that is most easily noticed. It is diffuse, with a burning or stinging sensation that worsens with movement and with cold weather. Patients are unable to indicate the origin of the pain. Joint stiffness appears because of the pain caused by movement. Early diagnosis and prompt institution of treatment are fundamental for improving these patients' condition, given that 50% of them evolve

to chronic pain<sup>(10)</sup>.

Finally, the diagnosis of infection requires orthopedists to “think” of this possibility. Acute infection with major edema and drainage is easily diagnosed. However, chronic infections with low virulence are more common and cause persistent pain with or without increased joint volume, especially if caused by anaerobic germs. Therefore, the diagnosis of infection should always be borne in mind by physicians when evaluating knee pain following TKA.

### Laboratory evaluation

Laboratory tests serve to help in defining the presence of infection. Hemograms, and specifically leukograms, will rarely be affected in prostheses with chronic infection. Tests on inflammatory activity are more sensitive for identifying infected knees. The erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) assay are the tests most used to prove the suspicion of infection. However, because these are screening tests, they present high sensitivity and a high number of false positives, such as in cases of systemic inflammatory disease. The presence of persistently elevated ESR and CRP greatly increases the suspicion of the presence of joint infection.

It is known that ESR remains high for three to six weeks after the surgery. The mean ESR in patients with infection is 57 mm/h, while in aseptic knees, this mean value is 27 mm/h. Thus, if the ESR is greater than 30 mm/h, there will be a high suspicion of infection, with sensitivity of 80%, specificity of 62.5%, positive predictive value of 47.1% and negative predictive value of 88.2%.

CRP remains elevated for three to four weeks after the surgery. If elevated CRP persists for more than four weeks, in conjunction with elevated ESR, this is a strong indicator of the presence of infection. The sensitivity and specificity of CRP are similar to those of ESR.

The first step in investigating a suspected infection is joint puncture. From punctures carried out on 86 knees on which arthroplasty had been performed (31 with signs of septic loosening and 55 with signs of aseptic loosening), Mason et al<sup>(11)</sup> demonstrated that the cell counts were of great value. Presence of 2,500 leukocytes per high magnification field, with 60% predominance of polymorphonuclear leukocytes (PMN) was highly indicative of the presence of infection, with a sensitivity of 98% and specificity of 98%.

Great care needs to be taken in making the punctures, in order to avoid contamination and false positives. It is not always possible to obtain a joint aspirate, especially in knees without hydrarthrosis. It is important to stress that patients should not be given antibiotics and should be given local anesthetic only on the skin and not intra-articularly. The material should be sent to the laboratory immediately, or should be sown in an enriched transportation medium at the time of the puncture<sup>(12)</sup>.

### Image assessment

1 – Simple radiography: This is important in evaluating the positions of the component and the presence of radiolucency, which may be indicative of loosening of the components (Figure 3).

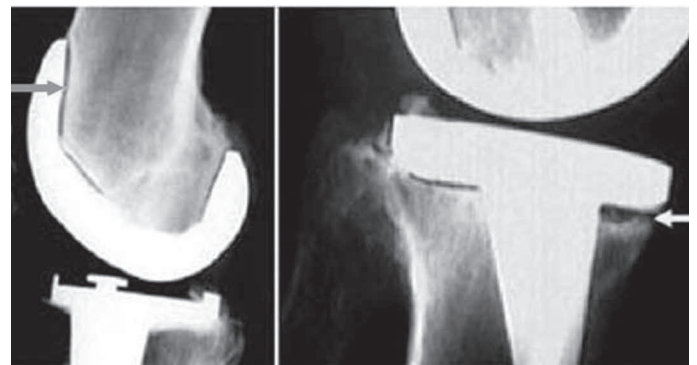
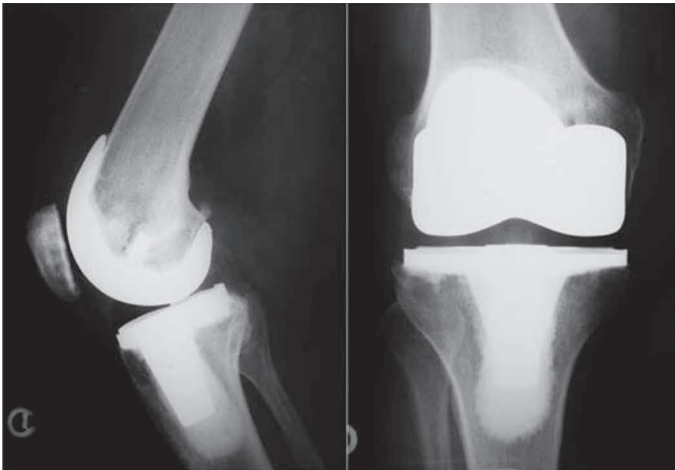


Figure 3 – Radiolucency lines in the femur and tibia (arrows).

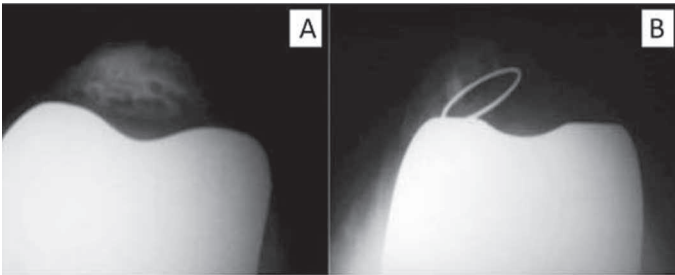
The anteroposterior (AP) view allows assessment of component alignment in terms of varus or valgus positioning and the possibility of rotation, along with the position of the joint line. If there is any periosteal reaction, gas in soft tissues or signs of early loosening, the diagnostic suspicion is directed towards infection. The lateral view documents the posterior inclination of the tibia, the height of the patella relative to the joint line and the relative position of the femur above the tibia, thus enabling identification of failure of the posterior cruciate ligament (Figure 4). Axial radiographs on the patella demonstrate the position of the patella in relation to the femur, thus documenting defects of rotation of the femoral component and dislocation of the patella (Figure 5).

Panoramic radiographs of the lower limbs are important for assessing the alignment of the implant in relation to the mechanical axis of the limb (Figure 6).

At this stage of the investigation, it is important for the surgeon to have access to the preoperative radiographs that defined the initial pathological condition of the



**Figure 4** – Postoperative control after TKA: evaluation of the size and position of the component.



**Figure 5** – Axial plane of the patella, showing good positioning (A) and subluxated patella (B).



**Figure 6** – Panoramic radiograph on lower limbs, showing bilateral TKA with restitution of the normal mechanical axis.

knee. Sequential analysis of the radiographs is fundamental for assessing the evolution of the radiolucency lines and the osteolytic areas. Small areas of radiolucency are not uncommon in asymptomatic patients and, for this reason, it is advisable to always view the first, the penultimate and the last radiograph. In this way, it becomes easier to document the appearance of or any increases in suspected lines of loosening, retrospectively over a long period.

Hip radiographs may demonstrate the presence of coxarthrosis (especially medial coxarthrosis), fracturing due to subcapital insufficiency and avascular necrosis, which are all sources of knee pain.

2 – Arthrography: This may have value in diagnosing component loosening, especially with regard to the tibial component, where it is easier to see the presence of contrast at the cement-prosthesis or cement-bone interface. However, this is not a routinely used examination. Because it is currently not a popular form of radiological examination, adequate imaging is only rarely achieved. Another important problem is the risk of contamination during joint puncture.

3 – Scintigraphy: This may demonstrate high uptake around the implants for many years after a successful arthroplasty procedure<sup>(13)</sup>. The initial labeling to be used is technetium-99m, which presents high sensitivity for demonstrating loosening, but low specificity. Loosening should be suspected when there is diffuse, increased and disproportional uptake and when the uptake is seen to increase when serial examinations are compared. Nonetheless, even if these characteristics are present, it is impossible to differentiate aseptic loosening from septic loosening. The main value of this examination is that it can demonstrate a normal situation, in which loosening can be ruled out<sup>(14)</sup>. Scintigraphy using leukocytes labeled with indium-111 should be interpreted in the same way as technetium is interpreted, when used alone. However, comparison between these two methods adds useful information, such that if the results diverge, this is suggestive of infection, with sensitivity and specificity of around 85%<sup>(15)</sup>. On the other hand, such comparisons are not routinely used.

4 – Ultrasonography (US): US may detect abnormalities in the superficial soft tissue, including the quadriceps tendon, patellar ligament and medial collateral ligament, with higher sensitivity than shown by postoperative magnetic resonance imaging on knee arthroplasty<sup>(16)</sup>. Furthermore, this examination correlates well with ra-

diographs in diagnosing worn polyethylene<sup>(17)</sup>, and it is a useful tool for guiding punctures into periprosthetic accumulations<sup>(18)</sup>. It is considered that this is an operator-dependent examination, and therefore its results must always be analyzed carefully.

5 – Computed tomography (CT): CT has precise indications for evaluations on these patients. This examination may be requested to provide greater accuracy of description for areas of osteolysis<sup>(18)</sup> or in cases of suspected periprosthetic fracture. Nonetheless, its greatest value is perhaps in determining whether implant rotation is present.

6 – Magnetic resonance imaging (MRI): MRI is directly affected by metallic artifacts, particularly those with irregular morphology and made of stainless steel. Changes to the image acquisition protocol may diminish the effect of such artifacts and thus demonstrate abnormalities such as osteolysis, soft-tissue injuries and failure fractures<sup>(18)</sup>. However, this examination is not routinely used in Brazilian settings for this type of investigation.

## JOINT-RELATED CAUSES OF PAIN AFTER TKA

The most important joint-related causes to be investigated are infection and component loosening. The diagnoses for these pathological conditions was discussed above: with a clinical history that may be characteristic, careful physical examination, the use of laboratory tests (especially hemograms, ESR and CRP) and careful analysis of the initial radiographs and the evolution of the radiographic images, it is possible to reach a definitive conclusion regarding the cause of the pain.

### 1 – Joint instability after arthroplasty:

Joint instability is one of the most common causes of painful arthroplasty, and among knee prostheses that are more than five years old, it is the most frequent cause of revision<sup>(18)</sup>. The instability may occur in the frontal, sagittal or axial plane. In the frontal plane, instability due to failure of the medial or lateral collateral ligament can be found, and this can be documented using stress radiography (Figures 7A, 7B and 8). Likewise, failure of the posterior cruciate ligament in patients in whom the initial prosthesis preserved this ligament gives rise to posteriorization of the tibia in relation to the femur, which may or may not be symptomatic (Figure 7C). Instability in the axial plane is more difficult to diagnose.

Axial displacement of the lower leg occurs under the femur when the patient is sitting on the examination table with the knee flexed. This is caused by increased flexion space. It is a subtle form of instability that may present as knee flexion because of lack of space in extension. The diagnosis is more difficult, since arthrofibrosis is the initial diagnosis because of the lack of complete extension. Most of these cases occur with implants that preserved the posterior cruciate ligament. According to

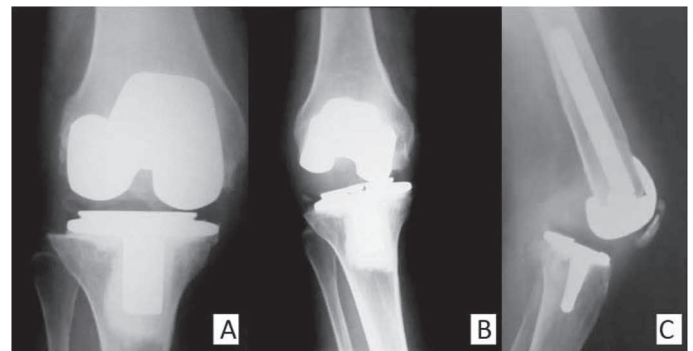


Figure 7 – Lateral instability (A and B) and posterior instability.



Figure 8 – Instability in the coronal plane caused by failure of the medial collateral ligament.

them have a history of joint dislodging and 73% improved through using an orthosis. Hydrarthrosis has been found to be a complaint common to all such patients, and 73% of them reported improvement of the effusion through rest<sup>(19)</sup>. In cases of doubt in the diagnosis, the use of a brace to stabilize the knee may help to clarify the cause of the pain: when the symptoms improve, the likely cause is instability of the prosthesis.

## 2 – Other joint-related causes of pain

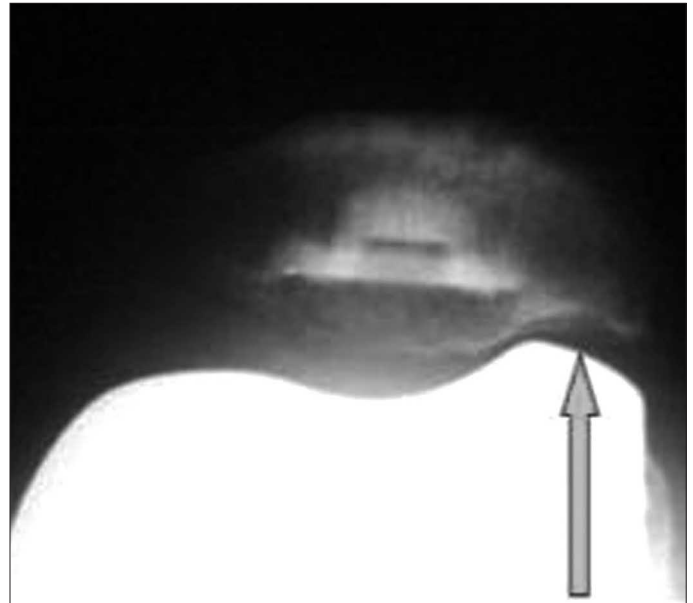
There are some causes of pain that provoke major dysfunction yet are relatively simple to diagnose, and these deserve to be mentioned:

*a.* Patellar clunk syndrome or patellar rebound syndrome: the diagnosis is characterized by a clunking sound or a rebound during flexion movement at between 30 and 45 degrees of flexion. The mechanical phenomenon is caused by a suprapatellar fibrous nodule that interferes with how the patella slides over the femoral trochlea. This phenomenon is closely related to the design of the femoral component and its incidence is up to 3.9% in Insall-Burnstein type II prostheses<sup>(20)</sup>. Around 50% of such patients evolve well just through observation<sup>(21)</sup>. For the others, the treatment is resection of the nodule, which can be done arthroscopically<sup>(22)</sup>.

*b.* Irritation of the lateral facet of the patella: if the patellar component is very small and implanted very medially and/or if the lateral osteophyte of the patella is not resected adequately, there will be a conflict between the lateral facet of the patella and the femoral implant, in the region of the lateral condyle, which will cause knee pain<sup>(23)</sup>. This should be treated by means of osteophyte resection or by changing the patellar component (Figure 9).

*c.* Popliteal tendon dysfunction: the rebound of the popliteal tendon on the edge of the femoral implant or on a posterolateral osteophyte may be painful<sup>(24)</sup>. During the operation, this phenomenon needs to be investigated using test implants, or even after fixation of the components. If a lateral rebound is present, both of these situations should be assessed, with correction of the implant size or resection of the osteophyte.

*d.* Protruding medial tibial component: if the tibial component is very big and forms a medial protrusion, medial pain will occur (Figure 2). The excess of the component functions as a medial osteophyte and causes pain due to distension of the medial collateral ligament. To avoid this complication, the size of the tibial component needs



**Figure 9** – Irritation of the lateral facet of the patella: if the patellar component is very small and is implanted too medially and/or if the lateral osteophyte of the patella is not adequately resected, there will be a conflict between the lateral facet of the patella and the femoral implant, in the region of the lateral condyle, which will cause pain in the knee (arrow).

to be adjusted precisely during the initial operation. The only solution after the surgery is to change the component.

## NON-JOINT CAUSES OF PAIN AFTER TKA

Non-joint causes of knee pain should especially be considered among patients who reveal that the current symptoms are similar to the preoperative symptoms. Neurological diseases such as peripheral neuritis caused by diabetes, hip diseases that cause irradiated pain in the knee (such as coxarthrosis), avascular necrosis and fracturing due to failure of the subchondral bone of the femoral head should be investigated. Vascular evaluations should always be performed in cases of suspected intermittent claudication.

Cutaneous neuromas occur more frequently than might be supposed. The diagnosis is not difficult, but surgeons need to take this pathological condition into consideration and to examine the knee adequately. It is important to emphasize that scar neuromas occur more frequently in knees that have undergone several previous operations. The infrapatellar branch of the saphenous nerve is the one most affected in TKA cases.

Bursitis and tendinitis are non-joint causes of knee pain that should be investigated clinically. Careful palpation of the knee may reveal these conditions.

As an exclusion diagnosis, psychological factors

pain that should be investigated clinically. Careful palpation of the knee may reveal these conditions.

As an exclusion diagnosis, psychological factors can be considered as causes of arthroplasty pain. However, such hypotheses should only be considered after completing the entire routine of the diagnostic investigation. Good preoperative counseling is important, so that the patient's and the surgeon's real expectations regarding the results from the procedure can be clarified. Mannion et al<sup>(25)</sup> prospectively evaluated 112 patients who underwent TKA. After two years of follow-up, it was noted that the patients had underestimated the time needed for the recovery; 85% of the patients believed that they would be completely free from pain, whereas this only occurred in 43% of the cases, and 52% thought that there would not be any functional limitations on their usual activities, whereas this was only found in 20% of the cases.

## CONCLUSIONS

Knees that present pain after TKA should be dealt with in a systematized manner, in order to reach a precise diagnosis. Treatment should only be instituted after the cause of the pain has been diagnosed, while bearing in mind that only 17% of the cases of pain of unknown origin that undergo revision present improvement in their condition.

The following sequence should always be followed: history, physical examination, laboratory evaluation and radiological evaluation. If this evaluation results in a diagnosis, the surgeon is thus authorized to institute the treatment. If not, the physician should place the case under observation and periodically repeat this sequence until reaching a diagnosis.

For readers interested in going further, we suggest that they should consult the review article published by Mandalia et al, whose ideas influenced and inspired us to compile this text.

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