

The management of patella infera in current practice

Jacques H. Caton

Received: 2 September 2009 / Accepted: 3 December 2009 / Published online: 19 February 2010
© Springer-Verlag 2010

Abstract Patella infera described by Caton et al. The measurement is made in 1982 is an accompanying symptom in certain knee affections secondary to the abnormal situation of the patella. The measurement is made on the X-ray with sagittal view after measuring the patellar height, using the original technique described by the author, when the ratio between the articular surface of the patella and the distance from the patellar tip to the tibial tubercle. Indications of surgery may be when this ratio is inferior or equals 0.6. The origin of the patella infera can be mechanical or inflammatory. The operative technique addresses the etiology. In current practice, the patellar height and the patellar tendon length may be evaluated using a sagittal section MRI. In the authors' experience, when the Caton ratio is lower or equals 0.6 and when the length of the patellar tendon is over 25 mm, the indication of surgery includes proximal transfer of the tibial tubercle. If the length of the patellar tendon is less than 25 mm, it is often necessary to perform a patellar tendon lengthening (PTL). This type of surgery is contraindicated in the authors' experience in depressive or pusillanimous subjects. The two surgical techniques are described. Both techniques use an anterior and medial approach. The proximal transfer of the tibial tubercle (PTT) includes medial and lateral retinaculum release. The tibial tubercle is detached and transferred upwards according to the pre-operative planning generally 1 or 2 cm and is fixed with 2 screws. PTL includes a medial and lateral retinaculum release often with the fat pad. The

patellar tendon is dissociated in the middle over its whole length, and the medial pad is detached of the tibial tubercle and the lateral of the patella. After lengthening, the edges of the tendon are sutured, and this suturing reinforced. Alternative procedures may be used when PTT or PTL are not possible, using transplantation with an allograft of the extensor system or a plasty with hamstring muscles.

Keywords Knee · Patella infera · Patellar height · Patellar tendon lengthening · Painful knee · Tibial tubercle · Tibial osteotomy · Patellar instability

Introduction

Historical perspective and definition of terms

Patellar instability is basically described as a mispositioning of the patella during the knee flexion. The patella is poorly maintained within the trochlear groove of the femur or may even dislocate externally.

French terminology describes the “*permanent dislocation*” when the patella is outside the groove as well in flexion as in extension; the term “*habitual dislocation*” when the patella is stable in extension and dislocates at any flexion over 20–30°; the term “*recurrent dislocation*” with abnormal mobility when patella tends to dislocate at the beginning of the flexion but finds the balance and the trochlear groove over 20°–30°. The term “*recurrent dislocation*” classically describes a “normal” knee that dislocates the patella after minor or major trauma and occasional onset. The term “*recurrent subluxation*” describes the situation when the patient complains of frequent episodes of “weakness” or “instability” of the extensor mechanism of the knee, without real documented dislocations. In the

J. H. Caton (✉)
Clinique Orthopédique Emilie de Vialar,
116 Rue Antoine Charial, 69003 Lyon, France
e-mail: jacques.caton@orthopedie.net; caton.jack@orange.fr

English literature, the term “*instability*” replaced the term “*subluxation*”, both terms being unspecific, as reported by David Dejour in the French “*Medical Encyclopedia*” in 1996 [1].

The anatomic situation of the patella in the sagittal plane may be “centered” or with “normal height” or “not centered”. In this second case, the patella may be riding high or low. The situation when the patella is riding high and the patellar tendon is long is related as “*Patella Alta*”. The word “Alta” comes from Latin. The opposite situation when the patella is in the inferior position describes the “*Patella Infera*” when the patellar tendon is short and the patella is outside the anterior femoral groove. The Spanish word “Baja” is sometimes improperly used for describing this fact.

Mentioned for the first time by Trillat in 1973, *patella infera* was studied and described in the literature in an original study by Caton et al. in 1982 [2]. Patella infera is usually an accompanying feature in certain knee affections and is rarely idiopathic. In the vast majority of cases, patella infera is secondary to iatrogenic mechanical lowering of the patellar tendon. It can also occur as a consequence of a reflex inflammatory sympathetic dystrophy syndrome [3–8].

Diagnosis of patella infera

Patella infera generates a distinctive pathology, dominated by knee stiffness, mainly in the inflammatory form [1]. The anterior part of the knee is painful, usually described as a burning sensation or “tight knee”, worsened by the physical effort. Bernageau, Gouttalier and co-workers described in two papers published in 1975 and in 1978 the relationship between the trochlea and the tibial tubercle on axial views. In average population, the length between the trochlear center and the tibial tubercle varies between 10 and 15 mm [9, 10].

The diagnosis of patella infera is made on the X-ray sagittal view by assessment of the patellar height. The measurements for the patellar position may be taken using the Caton Index (c), the Blackburne Peel Index (b) or the Insall-Salvati index (a) as shown in Fig. 1. We use the Caton index regularly for pre-operative planning and for the follow-up, and we proposed it in the French and in the international literature [2, 11, 12]. The calculation of any of the three indexes takes as a premise the anatomic observation that is found in normal knees, and there is a constant relationship between the length of patella (A) and length of the patellar tendon (B), as well as the width of the patella. The length of tendon (B) is measured on its posterior surface from the lower pole to the insertion on top of tibial tubercle; the length of patella by definition is greatest diagonal length measured. The ratio of LP to LT is 1:0, with less than 20% variation; hence, length of patellar tendon is

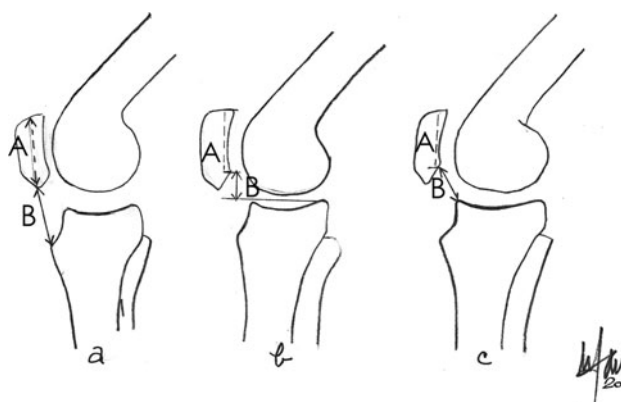


Fig. 1 Techniques for assessment of patellar tendon (a, b and c). The Caton ratio (c) with an ideal index between AT/AP = 1. In cases of patella infera, the AT/AP ratio is ≤ 0.6

approx. = to length of the patella; average ratio (LT/LP) = 1.02 w/SD of 0.13. When LP to LT ratio is less than 1:0, we can speak about patella alta. Patella infera is the opposite case when the ratio is lower than 85%.

Since 1977, we have been using our assessment index, modified in 1982, known as the Caton-Deschamps or as the Caton-Linclau Index, using a knee sagittal X-Ray view taken between 10 and 90° of flexion (Fig. 2). It may be useful to note that Linclau published his study describing the same technique for measurement of the patellar height in 1987 and it is referenced under both names in some papers [12].

The patella is low when the index is inferior or equal to 0.6. On a strict 30° axial view, the patella has a characteristic pattern, appearing “wedged” in the intercondylar notch with a superposed trochlear groove and complete loss of patellofemoral joint space.

Compared with the 30° “sunrise” view on the healthy side, the affected knee will show a “sunset” pattern (Fig. 3 and 3 bis).

Classification

The etiology of patella infera can be mechanical or inflammatory. The mechanical etiology is seen in associated quadriceps muscle pathology (paralytic poliomyelitis, rupture of the extensor mechanism), malformation.

Tibial tuberosity pathology following excessive distal transfer of the anterior tibial tubercle is an iatrogenic situation, well described in the literature [3–8]. This feature is worsened when associated to a constitutional genu recurvatum.

Patella infera may occur also in inflammatory conditions (associated or not with reflex sympathetic dystrophy). Retraction of the medial and lateral retinaculum leads to the secondary tendon retraction.

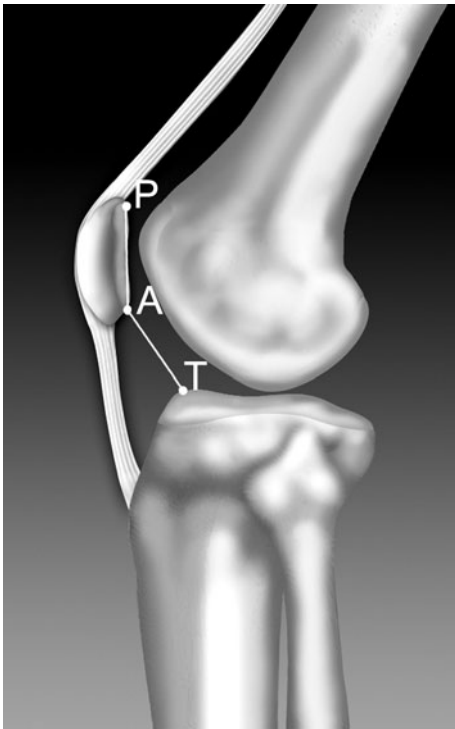


Fig. 2 The assessment of the Caton index



Fig. 3 and 3 bis Radiologic aspect of patella infera with the index $AT/AP = 0.7$ and the “sunset” aspect on axial view

Management rationale

The operative technique is different according to the etiology. In all cases, both the medial and the lateral retinaculum and often the fat pad ligament need a complete release. The mechanical patella infera, notably of tibial tuberosity origin, is treated by detachment and proximal transfer of the tibial tubercle or proximal patellar mobilization. The inflammatory patella infera of quadriceps origin is managed by patellar tendon lengthening when the patellar tendon is retracted. The patella infera of inflammatory etiology requires a knee release and per-operative range of motion assessment. Pre-operative planning should determine the length of the patellar tendon, ideally on MRI. The patellar height is assessed on a sagittal X-ray with the knee flexed between 10 and 90° for obtaining tension within the patellar tendon. The patellar height is modified in order to obtain an ideal index of 1.

Pre-operative planning

Pre-operative planning requires assessment of the patellar vertical height and of the patellar tendon length. The patellar vertical height is calculated as described in Fig. 2. Grelsamer delineated in 1992 different methods for assessment of the patellar height [13]. In our practice, we currently use the Caton ratio. The measurement of the patellar vertical height index according to this ratio is possible whatever the quality of the X-rays, knee size, degree of radiological enlargement, position of the tibial tubercle or eventual patellar modifications related to fractures, ossifications of the inferior pole, i.e. the method consists of plotting the distance between the inferior edge of the patellar joint surface and the antero-superior angle of the tibia (AT), and the joint length of the patella (AP). The ratio AT/AP varies between 0.96 ± 0.134 for men and 0.99 ± 0.129 for women, i.e. hardly different from 1. Age plays no influence. The normal patellar height (index AT/AP) is between 0.6 and 1.2. A vertical patellar height inferior or equal to 0.6 is known as patella infera (baja). An index superior or equal to 1.2 is known as patella alta (Fig. 4a). The precise assessment of the patellar tendon length requires a sagittal MRI view. According to Shabshin, who measured 245 subjects between 6 and 85 years of age, [14] the average length is 4.2 cm (2.8–6.3 cm) as described in Fig. 4b.

Indications: contraindications

Surgery is useful for patella infera when the patellar height index is inferior or equal to 0.6. Surgery when the index is

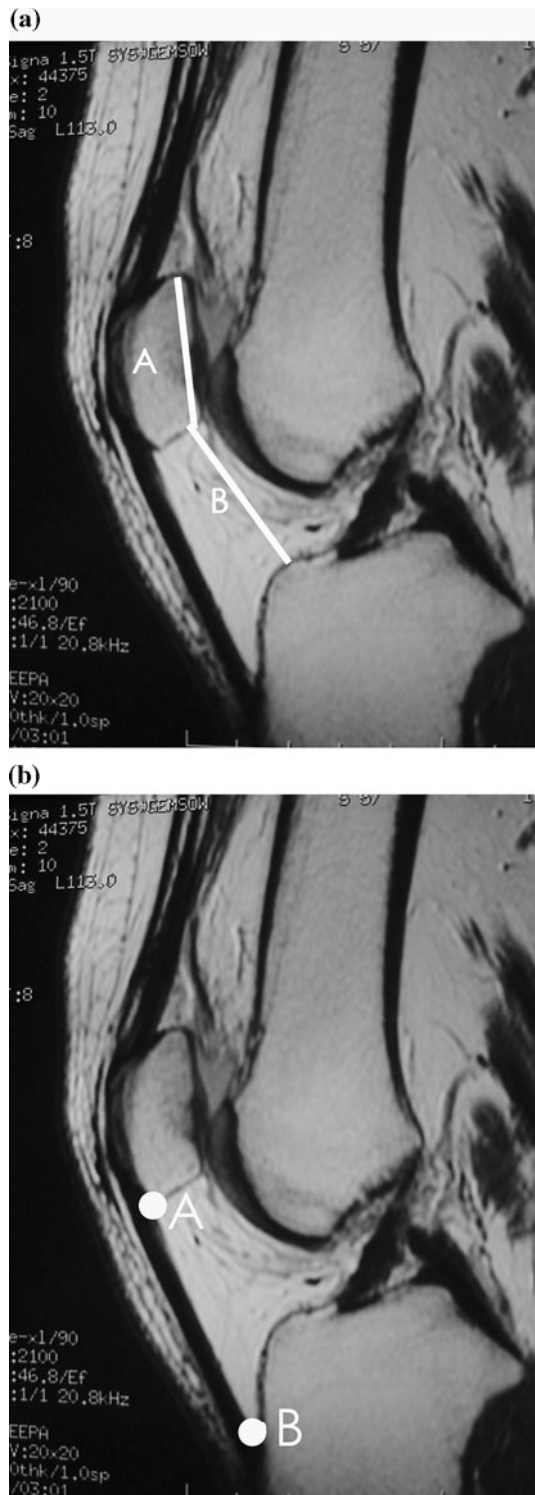


Fig. 4 **a** Measurement of the Caton index on MRI. **b** Measurement of patellar tendon length on MRI

over 0.6 (between 0.6 and 0.8) gives unsatisfactory results. When the patellar tendon is retracted ≤ 2.5 cm, it is often necessary to perform a patellar tendon lengthening as proposed by Dejour [1].

When the patellar tendon appears satisfactory longer than 2.5 cm, the tibial tubercle is detached and raised, according to the distance necessary to obtain a normal patellar height. Techniques for lifting the tibial tubercle anteriorly at the time of transposition, based on the work of Maquet [15] in patients with patellofemoral osteoarthritis, are not applicable to patellofemoral instability, according to Dandy [16].

Contraindications are mainly depressive and pusillanimous subjects.

Technique

This paper describes the proximal transfer of the tibial tubercle as originally illustrated in our paper from 1982 and (Fig. 5 and 5 bis) antero-medial approach, dissection of the patellar tendon, section of the peripatellar retinacular tissue, arthrotomy allowing arthrolysis of the knee and verification of the intraarticular space (this may also be done by arthroscopy). After section of the medial and retinacular tissue, the tibial tubercle is detached with a hammered chisel and is

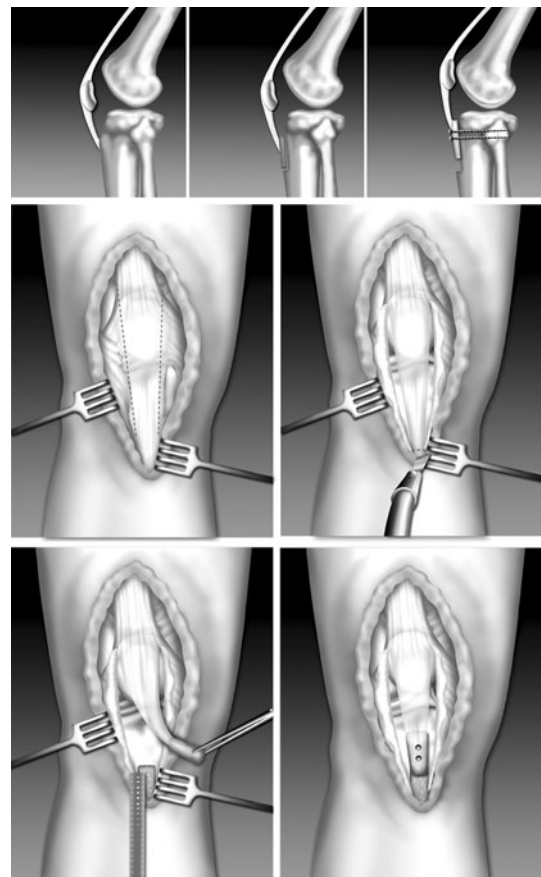


Fig. 5 and 5 bis Technique of proximal transfer of the tibial tubercle (as described by Caton)

transferred upwards according to the pre-operative planning, generally between 1 and 2 cm. It is fixed with two screws. The distal screw maintains the patellar height, and the proximal screw allows correction of the lateral transposition of the patella depending on the TTGT measurement and then secures it. The medial retinaculum is then closed, and the lateral retinacular edge is left open. One should take care that the patellar tendon is not folded when suturing the medial retinacular edge. Drain is inserted before suture. Post-operative immobilization is made using a splint, stiffened twill or plaster cast at 45° flexion. Walking without weight bearing is recommended for 3 weeks. Rehabilitation begins immediately after the surgical intervention under a loco-regional anesthetic block. The aim of this reeducation is to preserve knee mobility and good tension of the patellar tendon.

Lengthening of the patellar tendon as described by Dejour [11] is illustrated in Fig. 6 and 6 bis.

The approach is antero-medial, rising from the superior part of the patella and descending to the medial edge of the anterior tibial tubercle. As for the detachment of the anterior tubercle, the approach entails a very large dissection to the lateral and medial patellar tendon. It is often necessary to release the inferior and posterior aspect of the tendon and also to perform an arthrolysis by arthrotomy. Arthrotomy allows to inspect the patellar cartilage and to cut the fibrous bridles of the suprapatellar pouch. Patellar tendon lengthening is then carried out by Z plasty, dividing it through the middle over its whole length.

The lateral part remains anchored to the tibia distally and released proximally at the fibrous pre-patellar fascia level with the bone on the lateral half of the patella (lateral). The medial part remains anchored on the medial side of the patella at the top, whereas it is detached from the anterior tibial tubercle by means of a 2-cm tibial periosteal sleeve. The patella should rise naturally; the two parts of the patellar tendon sliding one beside the other. The correct height of the patella is confirmed by a per-operative sagittal knee fluoroscopy. The edges of the patellar tendon are then

sutured. The suture is reinforced either by absorbable PDS band or by hamstring tendon (semi tendinosus) fixed at the top on the patella and at the bottom at the level of the tibial tubercle.

The lateral retinaculum is left open, and the medial retinaculum is closed as the arthrotomy is performed. It is necessary to check that the suture is firmly fixed by carrying out a 90° flexion of the knee. The post-operative immobilization of the knee is realized in a cast or a posterior plaster splint at over 40° of flexion.

Results

Results of proximal transfer of the tubercle are illustrated in Fig. 7. Our experience includes a prospective study of 24 patients with this procedure, and none of them lost for follow-up. The results were assessed at minimum 2-year follow-up for pain, mobility, stability and resistance to fatigue and scored as excellent, good, average and poor. The patella infera syndrome with tubercle origin operated with this procedure gave 83% excellent and good results.

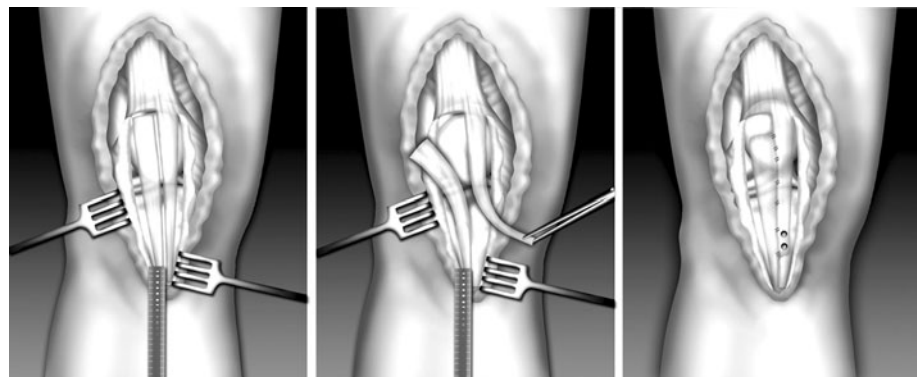
Results of patellar tendon lengthening (Fig. 8).

Our experience with the patella infera syndrome of quadricipital origin treated by lengthening of the patellar tendon includes a prospective study of 35 patients operated, and none lost for follow-up, with an average follow-up longer than 2 years. The good and very good results reached 74%. It is to be noted that the treatment of patella infera of quadricipital origin is difficult, especially when it is secondary to a reflex sympathetic dystrophic syndrome.

Complications

Mechanical complications include tibial tubercle avulsion at mobilization, rupture of the lengthened patellar tendon, insufficient correction and recurrence. Reports for complications and problems come from different authors. All of

Fig. 6 and 6 bis Technique of patellar tendon lengthening (as described by David Dejour)



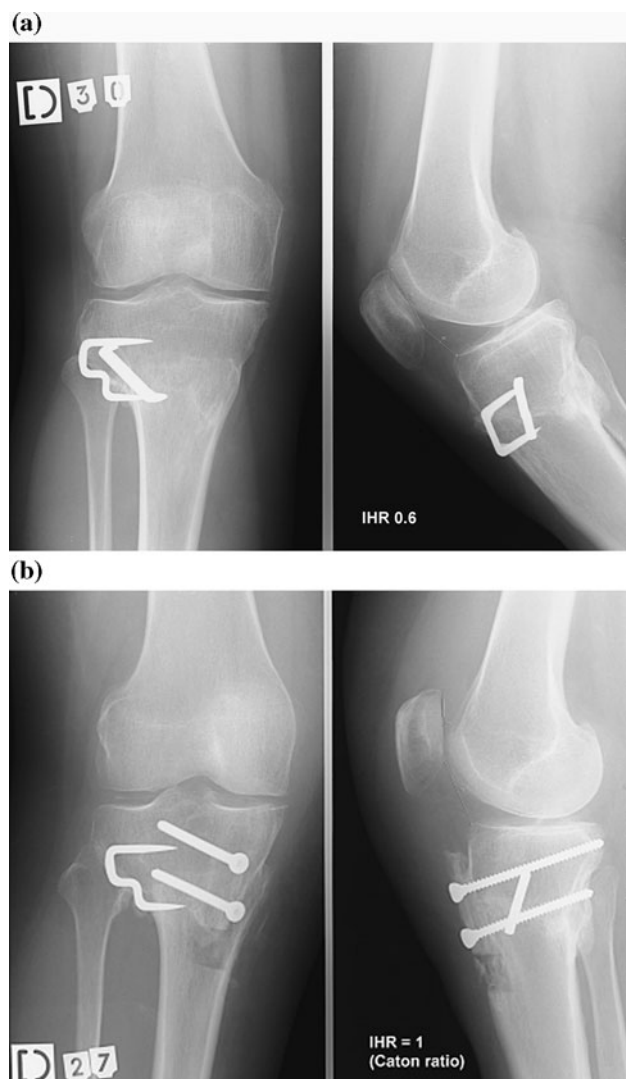


Fig. 7 and 7 bis Proximal transfer of tibial tubercle—results. Pre-operative ratio = 0.6. Post-operative ratio = 1

them outline the importance of the proper technical execution of the firm fixation and of the careful evaluation, rehabilitation and follow-up. Last but not least, the patient participation is essential as the muscular control and rehabilitation are important.

Inflammatory complications include knee stiffness and patella infera recurrence. We recommend immediate rehabilitation after surgery using a continuous passive motion system for 30 days.

Possible concerns and future of the technique

In the case of a too short patellar tendon or one that is partially destroyed, it may be possible to propose a total transplantation with a tendinous allograft or a plasty of the

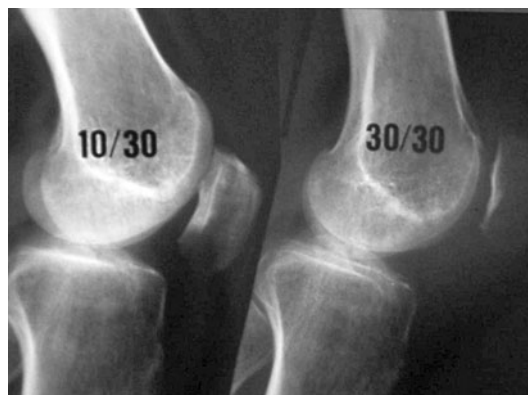


Fig. 8 Patella infera treated by patellar tendon lengthening with pre-operative and post-operative sagittal views

patellar tendon using hamstring muscles, allowing recovery of a normal patella height.

Conflict of interest statement No funds were received in support of this study.

References

1. Dejour H (1996) Instabilités de la rotule. In: *Traité d'Appareil locomoteur*, vol 3. EMC (Encyclopedie Medico-Chirurgicale), Paris, France, 14-328-A-10
2. Caton J, Deschamps G, Chambat P, Lerat JL, Dejour H (1982) Patella infera. Apropos of 128 cases. *Rev Chir Orthop Reparatrice Appar Mot* 68(5):317–325
3. Backstein D, Meisami B, Gross AE (2003) Patella baja after the modified Coventry-Maquet high tibial osteotomy. *J Knee Surg* 16(4):203–208
4. Miura H, Kawamura H, Nagamine R, Urabe K, Iwamoto Y (1997) Is patellar height really lower after high tibial osteotomy? *Fukuoka Igaku Zasshi* 88(6):261–266
5. Ozkaya U, Kabukcuoglu Y, Parmaksizoglu AS, Yeniocak S, Ozkazanli G (2008) Changes in patellar height and tibia inclination angle following open-wedge high tibial osteotomy. *Acta Orthop Traumatol Turc* 42(4):265–271
6. Sakai N, Koshino T, Okamoto R (1993) Patella baja after displacement of tibial tuberosity for patellofemoral disorders. *Bull Hosp Jt Dis* 53(3):25–28
7. Scuderi GR, Windsor RE, Insall JN (1989) Observations on patellar height after proximal tibial osteotomy. *J Bone Joint Surg Am* 71(2):245–248
8. Tigani D, Ferrari D, Trentani P, Barbanti-Brodano G, Trentani F (2001) Patellar height after high tibial osteotomy. *Int Orthop* 24(6):331–334
9. Bernageau J, Goutallier D, Debeyre J, Ferrane J (1975) New exploration technic of the patellofemoral joint. Relaxed axial quadriceps and contracted quadriceps. *Rev Chir Orthop Reparatrice Appar Mot* 61(Suppl 2):286–290
10. Goutallier D, Bernageau J, Lecudonnet B (1978) The measurement of the tibial tuberosity. Patella groove distanced technique and results. *Rev Chir Orthop Reparatrice Appar Mot* 64(5):423–428
11. Dejour D, Levigne CH, Dejour H (1995) La rotule basse post opératoire. Traitement par allongement du tendon rotulien. *Rev Chir Orthop Traumatol (Paris)* 81:286–295

12. Linclau L, Dokter G (1984) Iatrogenic patella “baja”. *Acta Orthop Belg* 50(1):75–80
13. Grelsamer R, Meadows S (1992) The modified Insall Salvati ratio for assessment of patellar height. *Clin Orthop Relat Res* 282:170–176
14. Shabshin N, Schweitzer ME, Morrison WB, Parker L (2004) MRI criteria for patella alta and baja. *Skeletal Radiol* 33(8):445–450
15. Maquet P (1976) Advancement of the tibial tuberosity. *Clin Orthop Relat Res* 115:225–230
16. Dandy DJ (1996) Chronic patellofemoral instability. *J Bone Joint Surg Br* 78(B-2):328–335