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## Knee Osteoarthritis and Associated Periarticular Conditions: Iliotibial Band Friction and Baker Cyst

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### 1. Introduction

Osteoarthritis (OA) is a highly prevalent disease with markedly increasing impact worldwide because of the aging of populations (Center for disease control and prevention (CDC); Murphy L. et al., 2008). It affects more than 21 million people in the U.S. (Handout on Health: Osteoarthritis), with 36% of elderly aged 70 or older having some degree of radiographic knee OA (D'Ambrosia et al., 2005; Felson et al., 1987). It is a major public health problem, with prevalence in the knee of approximately 30% in those over 65 years old (Felson et al., 1987).

The cause of knee pain in patients with OA remains unclear. Because hyaline cartilage has no innervations (Dye et al., 1998), the primary pathologic abnormality in OA (hyaline cartilage loss) could occur without pain. In MRI studies is reported an increase the prevalence of subchondral bone marrow edema, knee joint effusion, and synovial thickening in patients with symptomatic knee OA compared with patients with no symptoms (Hill et al., 2001; Felson et al., 2001). Knee with OA are biomechanically altered, and these changes may put stress on ligament and tendon insertion sites in and around the knee joint, creating pain (Hill et al., 2003). Some of the pain does not emanate from the joint itself but rather from the structures near the joint that contain pain fibers. Wide ranges of periarticular lesions occur around the knee joint, including popliteal Baker cyst (BC) (Vasilevska et al., 2008, Janzen et al., 1994) and friction of the iliotibial band (ITBF) (Vasilevska et al., 2009).

Iliotibial band friction syndrome (ITBFS) is an inflammatory overuse disorder affecting soft tissue, interposed between the iliotibial band and the lateral femoral condyle, caused by chronic friction (Muhle et al., 1999). Recently, an anatomic study disclosed a fibrous anchorage of the iliotibial band to the femur preventing rolling over the epicondyle; therefore ITBFS is mainly caused by increased pressure to the richly innervated and vascularized fat and loose connective tissue beneath the tract (Fairclough et al., 2006, 2007). Either ITBFS has been shown to cause lateral knee pain in athletes, it may be a consequence of gait changes induced by knee OA and may occur together with symptomatic knee OA (presented only 3 cases with low grade ITBF, only one with symptom) (Hill et al., 2003).

Recent reports have suggested a 60% reduction in cartilage volume in severe knee osteoarthritis (Vahlensieck et al., 2001; Fritschy et al., 2006). Medial compartment cartilage loss leads to varus deformity, which can affect knee biomechanics by altering the relationship of the iliotibial band and the lateral epicondyle with the possibility of an increased friction and pressure between these structures.

In contrary it is well known that popliteal (Baker) cyst is the most frequent encountered lesion around the knee. Among older individual with asymptomatic OA, popliteal cyst have a high prevalence (20,8%) (Hill et al., 2001). Cystic lesions around the knee may present as a painless palpable mass (Kornaat et al., 2006; Hill et al., 2003), with pain, with symptoms of tenderness in the posterior fossa (Hill et al., 2003) or to be detected during the routine MR imaging of the knee with suspected internal joint derangement (Mc Carthy et al., 2004), eventually when is large can be painful.

Multiple studies confirmed that intraarticular derangement play an important role in pathogenesis of popliteal cyst. MR studies of popliteal cyst demonstrated connection to one or more intraarticular lesions in 87-98% of the cases, like osteoarthritis or inflammatory arthritis; often joint effusion, meniscus tear and degenerative disease of the joint are found (Miller et al., 1996).

During the routine practice in cases with advanced isolated medial osteoarthritis (with subsequent genu varum) presence of MR signs of friction of ITB have been noted. The purpose of the study was to describe the frequency of fibrovascular tissue between the iliotibial tract and the lateral epicondyle in patients with severe isolated medial compartment osteoarthritis of the knee (Vasilevska et al., 2009). From this cases were selected those with Baker cyst, and the correlation between sizes of Baker cyst in patients suffering from medial compartment osteoarthritis of the knee was recognized and evaluated. The purpose was to describe the significance of the associated medial compartment knee osteoarthritis: cartilage degeneration, different degree of medial meniscus degeneration, bone edema and knee effusion.

In a study which was done 2009, in a 128 patients retrospectively selected from 700 MR examinations of patients with advanced medial compartment osteoarthritis of the knee, with > 80% loss of articular cartilage at the femur and the tibia, a relationship with MR signs of ITBF was presented. In this study MR signs for ITBF were present in 95 patients (74.2%). Out of them 91 patient had moderate signs for ITBF and 4 had severe MR signs for presence of fibrovascular tissue (Table 1) (Vasilevska et al., 2009).

|                  | ITBF<br>0 - absent | ITBF<br>1 - present | ITBF<br>2 - severe | total |
|------------------|--------------------|---------------------|--------------------|-------|
| Study<br>group   | 33 (25.8%)         | 91 (71.1%)          | 4 (3.1%)           | 128   |
| Control<br>group | 68 (72.3%)         | 26 (27.7%)          | 0                  | 94    |

Table 1. Presence of MR signs of ITBF in the study group with severe medial compartment osteoarthritis and in the control group (consensus reading).

Patients with complete cartilage loss as well as patients with subtotal cartilage loss showed tendency to further increase the incidence of MR signs of ITBF, when advanced degeneration of the medial meniscus was present (Table 2).

| Cartilage degeneration | Meniscus degeneration  | ITBF 0 - absent | ITBF 1 - present  | ITBF 2 - severe | Total             |
|------------------------|------------------------|-----------------|-------------------|-----------------|-------------------|
| complete loss          | 1 <sup>st</sup> degree | 0               | 2                 | 0               | 2                 |
| complete loss          | 2 <sup>nd</sup> degree | 2               | 7                 | 0               | 9                 |
| complete loss          | 3 <sup>rd</sup> degree | 14              | 42                | 2               | 58                |
|                        | total                  | 16 (12.5%)      | 51 (39.8%)        | 2 (1.6%)        | <b>69 (53.9%)</b> |
| subtotal loss          | 1 <sup>st</sup> degree | 3               | 9                 | 0               | 12                |
| subtotal loss          | 2 <sup>nd</sup> degree | 3               | 12                | 1               | 16                |
| subtotal loss          | 3 <sup>rd</sup> degree | 11              | 19                | 1               | 31                |
|                        | total                  | 17 (13.3%)      | 40 (31.3%)        | 2 (1.6%)        | <b>59 (46.1%)</b> |
|                        | Column Total           | 33 (25.8%)      | <b>91 (71.1%)</b> | <b>4 (3.1%)</b> | <b>128</b>        |

Table 2. Presence of MRI signs of ITBF in the group with severe medial compartment osteoarthritis correlated with cartilage degeneration and meniscal lesions.

Clinically, patients with medial sided osteoarthritis of the knee, occasionally also complain of laterally located pain. ITBF is unrecognized cause for lateral knee pain in patients with medial compartment knee osteoarthritis (Vasilevska et al., 2009).

When severe cartilage damage is associated with advanced degeneration of the medial meniscus, altered biomechanics probably with varus deformity, may contribute to the development of fibrovascular tissue between the iliotibial band and the lateral epicondyle on MR images as a recognized sign of ITBF (Fig.1) (Vasilevska et al., 2009).

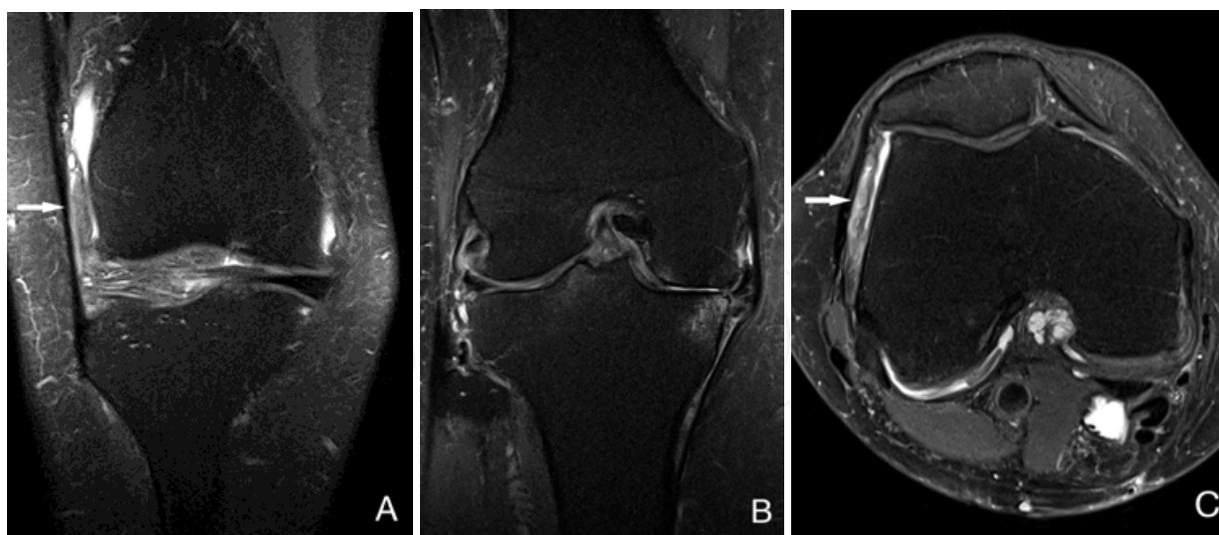


Fig. 1. A 72 y.o. woman with MR imaging signs of iliotibial band friction (ITBF) and medial osteoarthritis of the knee. Fibrovascular tissue (arrow) is seen between the lateral epicondyle and the ITB on PDw fatsat image (A). Some slices posterior the complete loss of hyaline cartilage at the medial femoral condyle and the tibia plateau with advanced degeneration of the medial meniscus is obvious. The lateral compartment is normal (B). On axial PDw fatsat image minor effusion and extensive fibrovascular tissue between the lateral epicondyle and the ITB is present (arrow, C) (Vasilevska et al., 2009).

In another study 66 cases were retrospectively evaluated its MR study of the knee with medial compartment knee osteoarthritis and MR signs of Baker cyst. The median age was 56,42 years, (age range 34-84 years). We selected two groups according to the size of the Baker cyst on MRI. The first group was with palpable soft tissue mass on medial aspect of popliteal fosa with a large Baker cyst, and in the other group the Baker cyst was small and detected only on MRI (Table 3).

|                  | Number of cases | Male/Female | Age (age range) |
|------------------|-----------------|-------------|-----------------|
| Large Baker Cyst | 31              | 11/20       | 54 (37-78)      |
| Small Baker Cyst | 35              | 12/23       | 59 (34-84)      |
| total:           | 66              | 23/43       | 56 (34-84)      |

Table 3. Sex and age distribution in cases with large and small Baker cysts

## 2. Imaging features

Magnetic resonance imaging (MRI) has enhanced our ability to examine patients non-invasively. This allows us to assess structural changes of osteoarthritis (OA) without risk to the patient. MRI enables to visualize and quantitate the changes in articular cartilage, the menisci, and other periarticular structures non-invasively (Wluka et al., 2001; Baranyay et al., 2007). MRI use in healthy populations and those with OA will detect a significant number of incidental lesions, some which are clinically significant and will require further imaging and clinical management (Grainger et al., 2008).

MRI may eventually eclipse plain radiography as the modality of choice for documenting structural progression of OA. Plain radiography remains the standard method for assessing progression. The measurement of radiographic joint space width is the most accepted and widely-used method of OA progression (Ravaud et al., 2008).

On MR images, cartilage thickness of the medial and lateral compartment should be measured centrally in the weight bearing zone. Degeneration of the medial meniscus had to be assessed, as well as subchondral bone marrow edema and effusion (Vasilevska et al., 2009).

The thickness of residual cartilage is measuring separately at the femur and at the tibia. The degree of degeneration of the meniscus is graded: 0- normal meniscus, 1- moderate degeneration with focal signal increase, 2- severe degeneration with some residual normal tissue and shape, 3-advanced degeneration of the meniscus with destroyed shape and no functional meniscal tissue.

Presence of MR signs for ITBF to be evaluated as well. For evaluation of MR signs of ITBF to be evaluated as well.

For evaluation of MR signs of ITBF (0-not present, 1-present, 2 severe changes) the following criteria can be used (Ekman et al., 1994; Muhle et al., 1999; Murphy et al., 1992; Nishimura et al., 1997; Vasilevska et al., 2009):

- poorly defined signal intensity abnormalities lateral, distal or proximal to the lateral epicondyle;

- signal intensity abnormalities superficial or deep to the ITT;
- localized fluid collection lateral, distal or proximal to the lateral epicondyle; (Fig.2).

To conclude that the reason of the lateral knee pain is ITBF in patients with osteoarthritis of the knee, which showed advanced medial compartment osteoarthritis with complete or subtotal (>80%) loss of articular cartilage at the femur and the tibia, lateral compartment should be normal including the articular cartilage and the lateral meniscus, without meniscal lesion or cartilage abnormalities (Vasilevska et al., 2009).

MR imaging allows confirmation of diagnosis of ITBFS and exclusion of other causes of lateral knee pain - such as meniscal tears or ligament injuries. Axial images are necessary to differentiate intraarticular fluid from ITBFS (Murphy et al., 1992).

Popliteal cysts on MR imaging are usually well defined, extending between the tendon of semimembranosus and the medial head of gastrocnemius into the gastrocnemius-semimembranosus bursa, situated superficial to the medial gastrocnemius muscle, along the medial side of the popliteal fosa (Torreggiani et al., 2002; Steiner et al., 1996). As cyst enlarge, the cystic fluid may extend in any direction. Inferomedial expansion is relatively common with a superficial location, which results in cysts becoming palpable (Torreggiani et al., 2002; Steiner et al., 1996). Baker cyst can be presented as a palpable soft tissue masses on the medial aspect of the popliteal fossa when it is distended and large (Fig.3) (Vasilevska et al., 2008).

On MRI, Baker cyst is presenting as a circumscribed mass with low signal on T1-weighted image, intermedial signal intensity on proton density (PD) image and high signal intensity comparing with skeletal muscle on PD-weighted fatsat image. The size of Baker cyst can be assessed by measuring the distension of the cyst, and when is thickened more than 1cm is a large cyst (Fig.4) (Vasilevska et al., 2008).

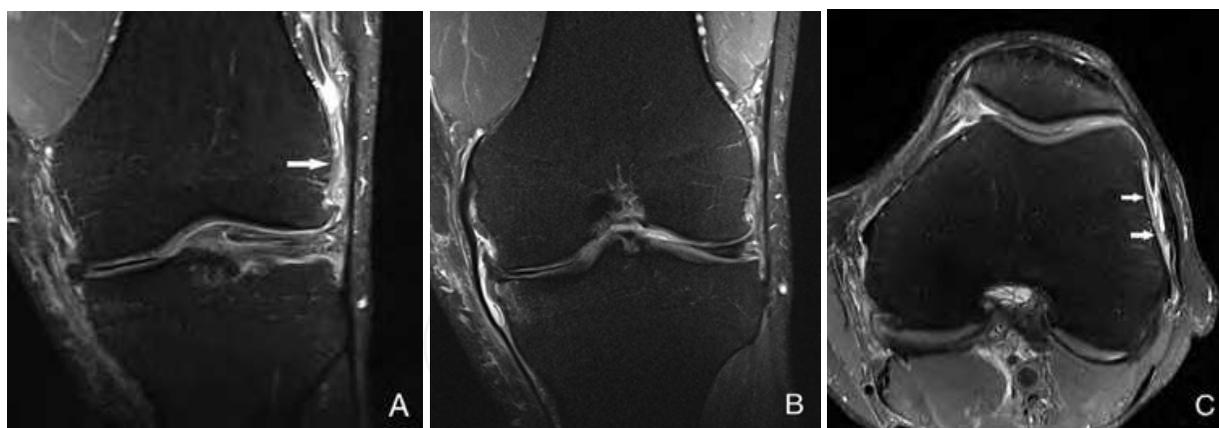


Fig. 2. A 61 y.o. man, medial sided osteoarthritis of the knee, associated with ITBF. Fibrovascular tissue and fluid collections (arrow) are located between the lateral epicondyle and the ITB at the lateral aspect of the left knee on PDw fatsat coronal image (A). Better seen on a section more posterior, osteoarthritis of the medial compartment is advanced with cartilage loss, vacuum phenomenon in the medial compartment and advanced degenerative desintegration of the medial meniscus (B). Axial PDw fatsat image again shows extraarticular fibrovascular tissues between the lateral epicondyle and the ITB (arrow, C) (Vasilevska et al., 2009).

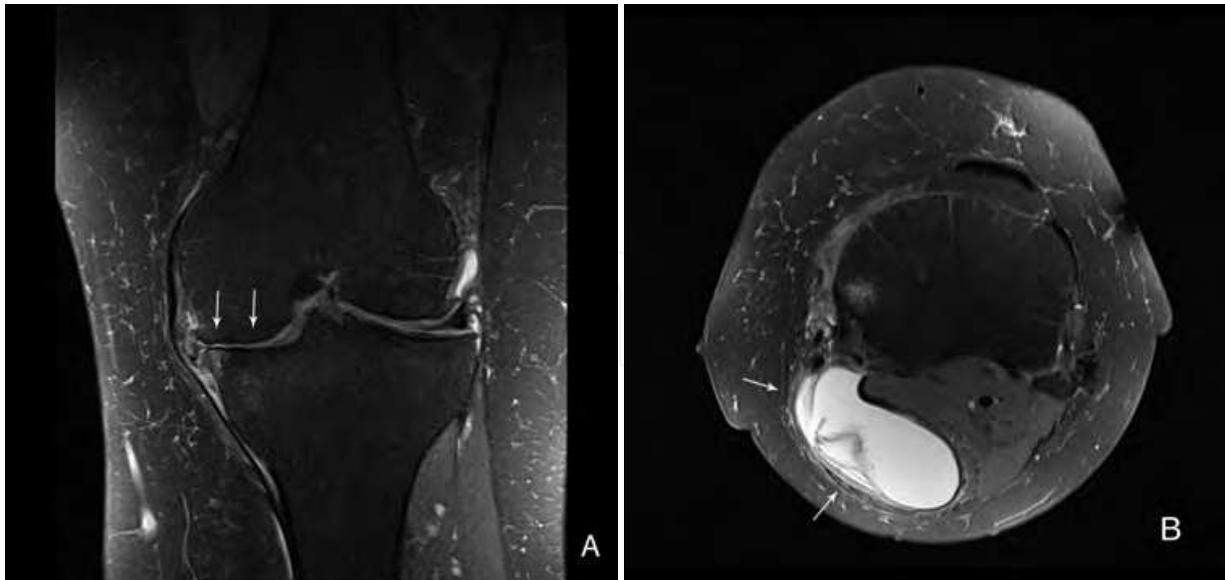


Fig. 3. Large Baker's cyst in a 59-year old woman; A) Coronal PDw fatsat image shows complete cartilage loss on the medial knee compartment with 3th degree medial meniscus degeneration with degenerative disintegration (arrows), the lateral compartment is normal including the hyaline cartilage and the lateral meniscus. B) Axial PDw fatsat image demonstrates a large Baker's cyst, with septum within the cyst (arrows) (Vasilevska et al., 2008).

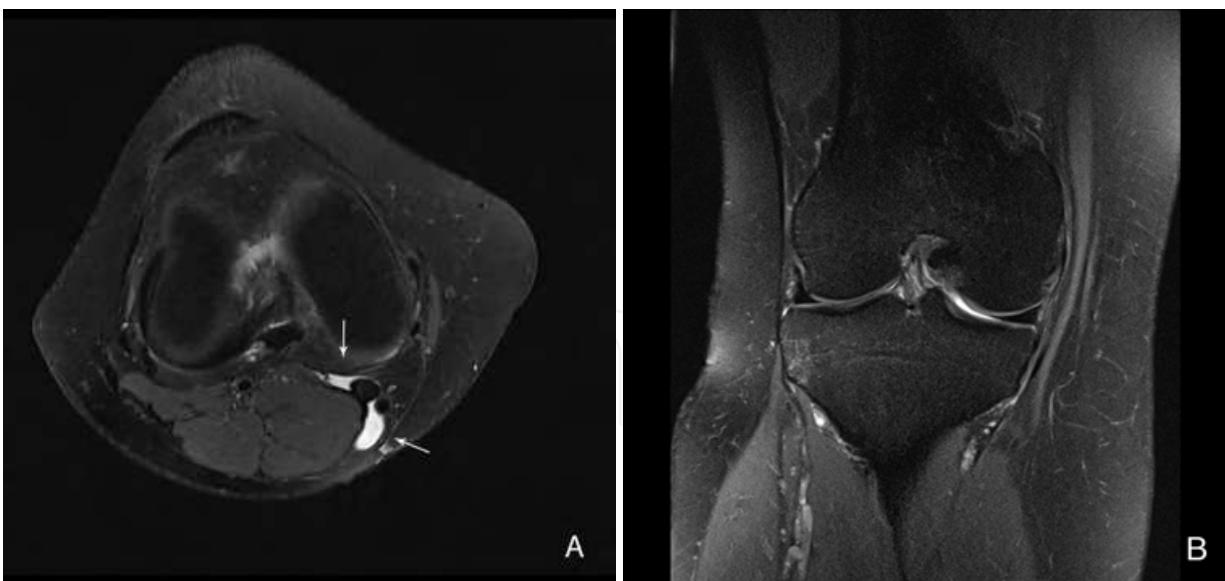


Fig. 4. Small Baker's cyst in a 35-year-old woman; A) Axial fatsat PDw images. Small Baker cyst is shown with its subgastrocnemius bursa and gastrocnemius-semimembranosus bursa connected by a thin neck (arrow); B) Coronal PD fatsat image of the same patient exhibits normal hyaline cartilage thickness without defects. Minor mucoid degeneration is shown of the posterior horn of the medial meniscus at its base without tear (Vasilevska et al., 2008).

### 3. Discussion

Some studies report an incidence of Baker cysts on MR images done for internal derangement of the knee of 5-58% with an increase in the prevalence with age, presence of arthritis, internal derangement and/or effusion (Miller et al., 1996; Ward et al., 2001). Sansone et al. noted that Baker's cyst were associated with one or more disorders detected by MRI in 94% of cases (Sansone et al., 1995). The results confirmed a strong association between popliteal cysts and intra-articular pathology (Sansone et al., 1995, 1999).

The popliteal cyst is almost never an isolated pathology in an adult knee (Fritschy et al., 2006). The probability of popliteal cysts increase with increasing number of associated knee conditions (Miller et al., 1996). Of 77 MRI-observed cysts, a statistical correlation existed with effusion, meniscus tears or "degenerative" arthropathy, or combination of these 3 maladies (Miller et al., 1996).

For fluid filled bursa have two etiological factors, knee joint effusion and persistence of one way valvular mechanism (Takahashi et al., 2005). Vahlensieck et al. mention that there is a communication with the joint in half of all cases, according to the anatomy literature. Therefore, a joint effusion may increase the size of the gastrocnemius bursae (Vahlensieck et al., 2001). Sowers MF et al. detected presence of joint effusion in 70% (507) in cases with the knee OA. They observed large baker cyst in 6,1% of the knee (Sowers et al., 2011). Marti-Bonmati L. et al. (2000) reported that the volume of Baker cyst was statistically related with presence of joint effusion in 70%. The presence and volume of the cyst is directly related with the quantity of the joint effusion, and the presence and type of meniscal lesion but not to the cartilage lesion (Marti-Bonmati et al., 2000). In isolated medial compartment knee osteoarthritis, there is no statistically significant difference between the size of the Baker cyst and degree of joint effusion (Vasilevska et al. 2008).

Other studies, in contrary, reported that there is a statistically significant correlation between Baker cyst and internal derangement of the joint without joint effusion. Internal derangement results from disturbed biomechanics with increased pressure to shift normal joint fluid into the bursa (Miller et al. 1996). The intraarticular pressure of the knee is increased with abnormal meniscus compared to healthy knees (Miller et al. 1996).

Almost all popliteal cyst are secondary cyst and degenerative cartilage lesions are responsible in 30-60% of the cases (Miller et al. 1996; Sansone et al. 1999). Articular cartilage lesion was the most frequent accompanying lesion with popliteal cysts and suggested an influence in pathogenesis of popliteal cyst (Rupp et al. 2002). An isolated degenerative alteration of the cartilage was present in 43% of the cases with Baker cyst (Sansone et al. 1995, 1999). Cartilage lesion, inflammatory and degenerative arthropaty are associated pathology with Baker cyst (Miller et al., 1996; Torreggiani et al., 2002; Ward et al., 2001; Handy et al., 2001; Vasilevska et al. 2008). In contrary, Marti-Bonmati et al. (2000) reported that they have not observed any statistically significant relation with presence and degree of the cartilage lesions.

In referred study of 30 patients with popliteal cyst in 90% had lesion of the posterior horn of medial meniscus (Sansone et al., 1999). Meniscal lesion was also directly related to the presence and quantity of fluid inside Baker cyst (Sansone et al. 1995; Marti-Bonmati et al., 2000). Although Baker cyst are more frequent with meniscus tear, their presence is also associated with menisci degeneration, especially of the posterior horn (Miller et al., 1996; Marti-Bonmati et al., 2000). Majority of cases with a Baker cyst usually were involved the medial meniscus (90%) and less frequently both menisci (17%) (Sansone et al., 1999).

Authors in study of 66 Baker cyst in cases with isolated medial compartment knee osteoarthritis concluded that in the cases with large Baker cyst, there is statistically significant difference between different degree of medial meniscus degeneration and distension of the cyst. The degree of medial meniscal degeneration has no influence on the distension of Baker cyst generally but an influence was found, when there is significant cartilage degeneration (Vasilevska et al., 2008). The same authors reported that the combination of medial compartment cartilage degeneration and medial meniscus degeneration are associated with large Baker cyst in 84%, but only 48% with small Baker cyst. In the group with large Baker cyst, isolated medial meniscus degeneration is present in 16%, comparing with association of medial meniscus degeneration in 52% from the cases with small cyst (Vasilevska et al., 2008).

Bone edema on medial compartment in isolated medial compartment osteoarthritis, can be present in 65% of the cases with large Baker cyst, only when cartilage degeneration is present. In cases with small Baker cyst, bone edema is present in 37% of the cases (Fig.5) (Vasilevska et al., 2008). In cases with both compartments knee OA, Sowers MF et al. reported the prevalence of bone marrow lesion in the medial compartment in 21,3% and in lateral 13,4 % (Sowers et al., 2011).

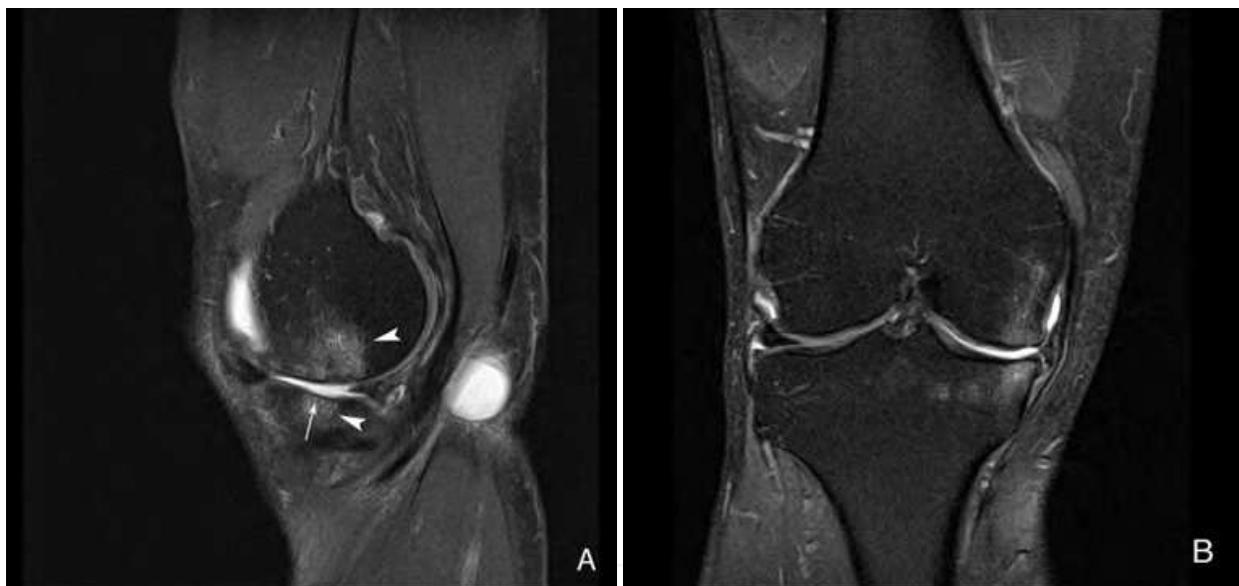


Fig. 5. Large Baker's cyst in a 67-year -old man; A) On a sagittal and B) coronal PDw fatsat image; complete cartilage lose on the femoral condyle and the tibial plateau of the medial compartment (arrows), with 3<sup>th</sup> degree of medial meniscus degeneration. Bone marrow edema (arrow heads) and effusion is present (Vasilevska et al., 2008).

There is a strong association between popliteal cysts and the severity of isolated medial compartment osteoarthritis, emphasizing the importance of cartilage degeneration for the distension of Baker cysts (Vasilevska et al., 2008).

It is well known that ITBFS is associated with overuse in long distance runners, cyclists, military personnel, football players, and weight lifters (Barber et al., 2007; Kirk et al., 2000; Fredericson et al., 2006,2007;). In runners the reported incidence is as high as 22,2% of all lower extremity injuries (Linenger et al., 1992), and it is 15% of all overuse injuries of the knee from cycling (Holmes et al., 1993). Excessive running in the same direction on a track,

downhill running, a lack of running experience, long distance running are the most often mentioned etiologic factors for ITBFS (Linenger et al., 1992; Messier et al., 1995). Weakness of the hip abductor muscles is also believed to play a role in the development of ITBFS (Fredericson et al., 2006; MacMahon et al., 2000). Football players and weight lifters can also suffer from chronic inflammation and fibrovascular tissue at the ITB proximal to its insertion into the anterolateral tibia. The causes of the ITBFS can be extrinsic (related to training technique) or intrinsic (related to the patient's anatomic alignment) (Farell et al., 2003; Fredericson et al., 2006; Nishimura et al., 2003).

Farell et al. (2003) emphasized that ITBFS usually occurs as a result of overuse. If, however, the patient has certain anatomical conditions (leg length discrepancies, varus knee alignment or excessive pronation and external tibial rotation of more than 20%), he/she will be more inclined to experience ITBFS. They concluded that knee-flexion repetition was more likely to result in the onset of the overuse injury ITBFS during cycling (Farell et al., 2003).

ITBFS is predominantly a clinical diagnosis.

Several other anatomical abnormalities, including leg length discrepancy and functional overpronation of the foot have been postulated as predisposing factors (Nishimura et al., 2003). Nishimura et al. (2003) described also two non athletic patients with ITBFS.

As a possible factor contributing to the development of ITBFS, genu varus has been described, in runners and in athlete that may increase the tension and thus a frictional force over the lateral femoral condyle (Jones et al., 1987; Sutker et al., 1981).

The finding of predominant cartilage degeneration on the medial rather than the lateral tibia plateau side suggests a close relation to the varus- knee osteoarthritis present in most of the cases (Kleemann et al., 2005). Recent reports have suggested a 60% reduction in cartilage volume in severe knee osteoarthritis (Burgkart et al., 2001; Cicuttini et al., 2001).

Significant correlation between joint space narrowing and cartilage volume was reported (Cicuttini et al., 2001). Medial compartment cartilage loss leads to varus deformity, which can affect knee biomechanics by altering the relationship of the iliotibial band and the lateral epicondyle with the possibility of an increased friction and pressure between these structures. An association of ITBFS with genu varum in runners has been previously established (Farell et al., 2001).

There is only one study in literature of 128 MR of the knee, we published a 2009, that describe the correlation of advanced isolated medial compartment knee osteoarthritis (with subsequent genu varum) and MR signs of friction of ITB (Vasilevska et al., 2009). Cartilage volume was not measured but the cartilage thickness in the weight bearing zone, to assess if there was a significant difference on cartilage thickness between the medial and the lateral compartment. There was a significant difference in cartilage thickness between medial and lateral compartment which led to joint space narrowing when standing and varus deformity of the knee. Varus knee alignment may be one of the causes for permanent stretching of the ITB and even during walking, to cause friction of the ITB on the femoral lateral condyle which leads to inflammation of the fibrovascular tissue, thus presenting signs of ITBF on MRI (Vasilevska et al., 2009).

#### 4. Conclusion

Advanced reduction of cartilage thickness combined with severe degeneration of the meniscus at the medial compartment probably leads to biomechanical changes, and varus knee alignment. It may be the cause for stretching of the ITB, and may be one of the reasons

for ITBF. A latest statement for the so frequent presence of MR signs of ITBF in patients with isolated medial compartment knee osteoarthritis, give us a rights to put this entity in the list of an important associated entities with knee osteoarthritis. We should always think about it as the reason for lateral knee pain in those cases. This can be an explanation for the presence of lateral knee pain, when lateral knee compartment is unaffected.

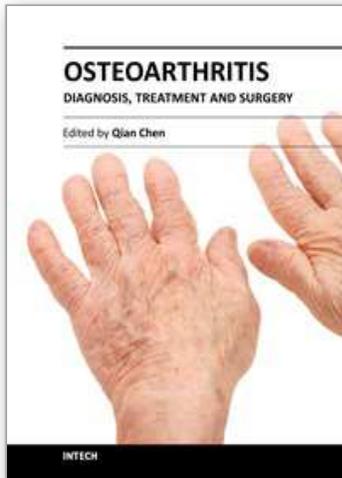
Baker cyst is not a single joint lesion, but it is associated with cartilage and meniscus degeneration on the medial compartment of the knee joint. Its size is strongly correlated with degenerative changes of the cartilage on the medial compartment and medial meniscus degeneration. It is not connected with a joint effusion. The size of Baker cyst had a strong correlation with degenerative changes of the cartilage and with the degree of meniscus degeneration on the medial compartment of the knee joint. Presence of distended Baker cyst can be one of the reasons of the pain and discomfort in the posterior aspect of the knee.

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## **Osteoarthritis - Diagnosis, Treatment and Surgery**

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Osteoarthritis is one of the most debilitating diseases affecting millions of people worldwide. However, there is no FDA approved disease modifying drug specifically for OA. Surgery remains an effective last resort to restore the function of the joints. As the aging populations increase worldwide, the number of OA patients increases dramatically in recent years and is expected to increase in many years to come. This is a book that summarizes recent advance in OA diagnosis, treatment, and surgery. It includes wide ranging topics from the cutting edge gene therapy to alternative medicine. Such multifaceted approaches are necessary to develop novel and effective therapy to cure OA in the future. In this book, different surgical methods are described to restore the function of the joints. In addition, various treatment options are presented, mainly to reduce the pain and enhance the life quality of the OA patients.

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