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Short Communication

Basics and mimics of Double Posterior Cruciate Ligament (PCL) sign

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Abstract: The double posterior cruciate ligament (PCL) sign is characteristic MRI sign of bucket handle tear of medial meniscus in patients with the intact anterior cruciate ligament. Bucket handle tear is displaced vertical longitudinal tear with displacement of the inner fragment (resembling the handle of a bucket) into intercondylar notch parallel to posterior cruciate ligament with residual larger peripheral part of the meniscus resembling the bucket. On MRI, the double posterior cruciate ligament (PCL) sign is seen as a low-signal-intensity band that is parallel and anteroinferior to the PCL on sagittal images. Double PCL sign is a highly specific indicator of bucket-handle tear of the medial meniscus. However, knowledge of mimics of this sign which include few normal and abnormal structures in the intercondylar fossa, such as meniscomeniscal ligaments, ligament of Humphrey and Wrisberg (accessory meniscofemoral ligaments), loose bodies, fracture fragments, double-barrelled PCL is important to avoid fallacies. Primary treatment of bucket handle tear is arthroscopic repair**.**

Keywords: PCL (Posterior cruciate ligament), ACL (Anterior cruciate ligament), bucket handle tear, medial meniscus.

DISCUSSION

The posterior cruciate ligament (PCL) is intra-articular and predominantly extrasynovial. PCL has femoral attachment at the semicircular area on the lateral aspect of the medial femoral condyle and tibial attachment in the intercondylar region at a sulcus in posteroinferior part of the articular plateau. It consists of two bundles: a larger anterolateral and smaller posteromedial bundle[1,2]. Its average length and width at its midportion, as reported by Girgis et al. are 38 and 13 mm, respectively[3]. The cross-sectional area of PCL is 50% greater than the anterior cruciate ligament (ACL) at the femur and 20% greater at the tibia. In contrast to ACL, the PCL is larger at its femoral insertion than at its tibial insertion. Ligaments of Humphrey and Wrisberg, the meniscofemoral ligaments, extend from the posterior horn of the lateral meniscus to medial femoral condyle, inserting anterior and posterior to the PCL, respectively and are secondary stabilizers of knee preventing posterior translation of tibia [1]. PCL is supplied by the middle genicular artery and is innervated by the tibial and obturator nerves. It primarily has proprioceptive function.

The medial meniscus is a C-shaped fibrocartilaginous structure lying between the medial femoral condyle and tibial plateau with anterior horn attached to the anterior surface of the tibia well off the tibial plateau and posterior horn attached to posterior part of the joint capsule. In mid part, it is attached to the femur and tibia through the deep medial ligament. The two menisci, medial and lateral, are attached to each other by transverse ligament and to patella by patellomenis calligaments[4]. The menisci are supplied by inferior and superior lateral and medial genicular arteries [5] and are innervated by free nerve endings[6]. Medial meniscus measures approximately 40.5-45.5 mm in length and is approximately 27 mm wide[7]. The medial meniscus is firmly attached to the joint capsule while lateral meniscus is relatively more mobile. The menisci are avascular with only peripheral vascularisation. Only outer third of the meniscus has innervation, thus associated with pain. The menisci function as shock absorbers and also play role in joint lubrication and stability [8]. Meniscal tears are of several types, predominantly Longitudinal, Horizontal, Radial and Flaptears and are three times more common in the medial meniscus than lateral, being more common in young adults with history of locking, extension block or slipping of the joint [9].

Post-traumatic meniscal tears often result in the displacement of the torn fragment away from the parent meniscus. Such displaced meniscal tears must be correctly diagnosed as most of these tears require surgical repair. Timely intervention can be done only if proper diagnosis is made. Bucket handle tear is a vertical tear of posterior horn of medial meniscus resulting in a large bucket-handle fragment of medial

meniscus flipped into the intercondylar notch. The fragment is tethered both anteriorly and posteriorly by the root attachments of the meniscus. In patients with intact anterior cruciate ligament (ACL), the fragment comes and lies anteroinferior to posterior cruciate ligament (PCL).

Fig1. T2 weighted and PD sagittal images showing displaced meniscal fragment in a patient with medial meniscal tear lying parallel and anteroinferior to posterior cruciate ligament in intercondylar notch depicting the double PCL sign.

While the double PCL sign is not sensitive for bucket handle tears, it is fairly specific. Patients present with pain along the joint line, knee locking with history of recent trauma. On examination, joint line tenderness and crepitus may be found. Most common cause is sports trauma or twisting of the knee in young patients. Despite the chronic tear, most patients can perform routine activities and even sports activities. Bucket-handle tears are commonly Post-traumatic and need urgent surgery. The double posterior cruciate ligament (PCL) sign is seen on midline sagittal magnetic resonance (MR) images of the knee as a low-signal-intensity band that is parallel and antero inferior to the PCL. It is associated with bucket-handle tears of the medial meniscus that occur in the presence of an intact ACL. A bucket-handle tear is a vertical longitudinal tear of meniscus leading to displaced but attached meniscal fragment[10]. In patients with intact ACL, further lateral displacement of torn meniscal fragment does not occur resulting in aparallel orientation. Thus, ACL plays a pivotal role in double PCL sign. Double PCL is named after the appearance of two parallely oriented hypointense structures, the torn meniscal fragment, and PCL both of which show low signal intensity on MRI.

Double ACL sign was recently described by Takayama *et al*, in which the displaced meniscal fragment lies anterior to the ACL. This sign occurs with a longitudinal tear in the anterior horn of medial meniscus extending upto theposterior horn. [11] This sign can be mimicked by displaced medial patellofemoral ligament / vastusmedialis [12].

Early identification of bucket-handle tears is critical for timely repair and hence, to prevent maceration of the torn part. Arthroscopic repair with excision or reattachment of the free fragment is primary treatment [14-16]. MRI diagnosis has a sensitivity of approximately 60–88% for bucket handle tears [14]. Previously, the sensitivity of double PCL sign for bucket-handle tears was thought to be 100% [13,15]. Specificity of double PCL sign is approximately 98–100% making it highly specific for bucket-handle tear[17].

Ligament of Humphrey, a normal accessory meniscofemoral ligament, which extends from the posterior horn of the lateral meniscus to the lateral aspect of the medial femoral condyle, is a potential pitfall of the double PCL sign. [13,15]. However, ligament of Humphrey is smaller and thinner and lies in close proximity to the PCL[15]. Ligament of Wrisberg, another meniscofemoral ligament, normally seen as a dot on sagittal images, may be parallel to PCL in externally rotated knee or lax ligament of Wrisberg and can be differentiated by tracing its origin.

Another pitfall is the oblique meniscomeniscal ligament, a normal anatomic variant[18]. The two oblique meniscomeniscal ligaments are named after anterior attachment site. Medial oblique meniscomeniscal ligament originates from the anterior horn of the medial meniscus and inserts into the posterior horn of the lateral meniscus while the lateral one originates from the anterior horn of the lateral

meniscus and inserts into the posterior horn of the medial meniscus, both of which cross between the ACL and PCL in themidline. Hence, tracing their course would avoid this pitfall. Intraarticular loose bodies may also mimic double PCL, and can be differentiated by the absence of a meniscal defect. Displaced flap tear of the meniscus can be differentiated by the absence of attachment to anterior and posterior horns. Sometimes, even a chronic ACL tear with stump lying horizontally in the region of the intercondylar notch may be a mimic, and can be differentiated by assessing ACL integrity.

Other signs for bucket-handle meniscal tears include absent bow tie sign, central meniscal fragment, the fragment-in-notch sign, flipped meniscus sign, and double PCL sign in decreasing order of importance[14, 16, 17, 19].

Bucket-handle tears are treated by surgical repair done by arthroscopy. Delay in treatment must be avoided because untreated tears may increase in size and may abrade articular cartilage, leading to arthritis. Chronic cases may show scarring of the fragment into the intercondylar notch and failure of reduction. Meniscal tears have variable healing potential depending on the type, location, length and stability with partial tears and stable vertical tears in the vascularised peripheral zone being faster to heal than others[20].

Non-operative treatment includes rest with activity modification, physical therapy, ice, and nonsteroidal anti-inflammatory drugs (NSAIDs). Aims of physical therapy program are to minimize the effusion, normalize gait, attain apain-free range of motion, and prevent muscular atrophy. Spontaneous healing of bucket handle tears has been reported in few cases[21]. The preferred treatment for bucket handle meniscal tear is arthroscopic meniscal repair to prevent further injury to the meniscus and cartilage.

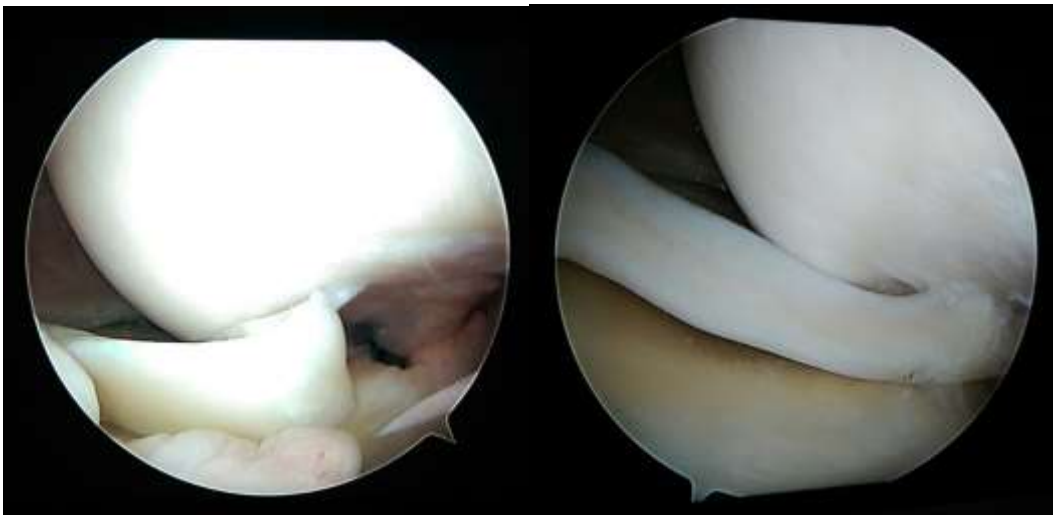

Fig 2: Arthroscopic view of displaced flap of meniscus tears with stump lying horizontally in the region of the intercondylar notch

To conclude, the double PCL sign is the presence of a low-signal-intensity band that is parallel and anteroinferior to the PCL on sagittal MRI and is a highly specific indicator of a bucket-handle meniscal tear. It is most commonly seen with medial meniscal tears in the presence of intact ACL. Knowledge of its pitfalls and anatomical variations is important for timely diagnosis and treatment by arthroscopic repair.

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