

ORIGINAL ARTICLE

Anterior Cruciate Ligament Pathology as a Predisposing Factor for Bucket Handle Meniscal Tear

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Abstract

Objective. To test if the presence of anterior cruciate ligament pathology is a predisposing factor for the occurrence of a bucket handle tear of the meniscus.

Materials and methods. In a retrospective double-center setting, 3340 consecutive knee MRI examinations dated between October 2018 and March 2021 with various 1.5 and 3T MRI machines have been reviewed. All cases with bucket-handle tear of the meniscus have been sought. From the bucket handle cases, only those with available previous MRI examinations showing unremarkable meniscus were included.

Results. From the evaluated 3340 knee MRI-scans, 36 cases with bucket handle tears were identified (30 and 6 cases involving the medial and lateral meniscus, respectively). Nine out of 36 cases had previous MRI-scan with a non-tear status of the involved meniscus. Interestingly, all these nine cases showed a clear anterior cruciate ligament abnormality prior to the occurrence of bucket handle tear. The nature of the associated anterior cruciate ligament pathology ranged from complete and previous reconstruction in tear in 3 and 6 cases, respectively.

Conclusion. A significant association between underlying anterior cruciate ligament pathology and later development of bucket handle tears of the meniscus could be shown. This result highlights the importance of the proprioceptive role of the anterior cruciate ligament in maintaining knee stabilization which can result in further structural meniscal injuries and therefore underlining the necessity of addressing the menisci during its anterior cruciate reconstruction and the importance of their clinical and radiological follow-up

Keywords: Bucket-handle; Anterior Cruciate Ligament; ACL-Reconstruction; Knee Trauma.

INTRODUCTION

Bucket handle tear is a longitudinal tear of the meniscus that results in a displacement of a meniscal fragment towards the intercondylar notch. The occurrence of bucket handle tear is known to be higher at the medial meniscus compared with the lateral side. Bucket handle

tear is known to be associated with anterior cruciate ligament (ACL) tear. A systematic intraoperative assessment concluded that bucket handle tears were present in 11% of cases with ACL tear [1].

The ACL is an important structure in the knee joint, which serves in several

mechanical functions, including restraining of the anterior tibial translation, as well as, prevention of varus and valgus subluxation in the extended knee. In addition to that, a proprioceptive function of ACL has been studied, and histologically proven in humans and animals [2, 3, 4, 5]. Disruption of the proprioceptive function can alter normal dynamics of the knee joint, leading to further instability [6].

Few reports have described the relationship between injured ACL and bucket-handle tear of the meniscus and to the best of our knowledge, no report has described bucket handle tear of meniscus in chronic ACL-insufficiency or after ACL reconstruction using previous MRI scans. Our hypothesized that the presence of an ACL injury even post reconstruction is a predisposing factor for later development of a bucket handle tear of the meniscus.

MATERIALS AND METHODS

Patients:

A retrospective PACS-search and evaluation of 3340 consecutive knee MRI examinations scanned between October 2018 and March 2021 with various 1.5 and 3T MRI machines has been performed at two institutions. The assessed scans all included standard knee MRI protocol, containing coronal T1, proton density fat saturated sequences, axial STIR and sagittal proton density fat saturated and STIR sequences with 3-4 mm thickness. Field of view ranged from 14-16 cm. Looking for cases with a bucket-handle tear of the meniscus were independently performed by two radiologists with more than 7 years of experience in musculoskeletal imaging.

Image Assessment:

The resulting 36 cases with a bucket handle tear of the meniscus were thoroughly

assessed regarding associated ACL pathology. The ACL showed normal appearance in nine cases (25 %), on the other hand it showed a clear pathology in the rest of cases (27 cases, 75%). The type and nature of the associated pathology was divided into three groups, i.e., complete rupture, partial rupture and status post ACL reconstruction, which were present in 11, 12 and 6 cases, respectively. Partial rupture has been defined as ligamentous signal alteration and distension with preservation of its alignment while complete rupture has been defined as signal alteration along with loss of its continuity.

Exclusion criteria for this selection were: the presence of a meniscal tear in the initial MRI scans, as well as, the interval occurrence of other internal knee pathology in the newer scans which can affect our hypothesis in studying the ACL role in development of Bucket-Handle tear.

Results:

From the evaluated 3340 knee MRI-scans, 36 cases with bucket handle tear of the meniscus were identified (21 male and 15 female patients). 22 cases were present at the right side compared with 14 cases on the left. Patient age ranged from 19 to 67 years with mean age of 38.4 years and standard deviation of 12.9 years. 30 cases had medial meniscus tear, and 6 cases showed a tear of the lateral meniscus. A coincidental ACL pathology was observed in 27 cases.

Previous MRI scan were sought in all 36 cases, resulting in nine cases had a previous MRI scan that showed unremarkable meniscus. Of these nine cases, there were eight male patients and one female patient, with an average age of 28 years. Left and right knee involvement was seen in five and four cases, respectively. Time intervals between the MRI scan with non-tear status and the later MRI

with presence of the bucket handle tear ranged from 6 to 75 months, with a mean interval of 27.8 months and standard deviation of 20.7 months. The medial meniscus was involved in eight cases, and the lateral meniscus was seen in one case. No other interval pathology was detected in newer scans of the nine cases, nor history of recent trauma.

We have found that all cases developed interval bucket handle tear over the time

period between the first and the second MRI scans (nine cases) showed an ACL abnormality in the first scan. These ACL abnormalities ranged from three cases with complete ACL tears and six cases with previous ACL reconstruction (Figure 1, 2) (Table 1). The six cases with status post ACL reconstruction showed intact alignment of the ACL graft on the second MRI scan.

Table 1: Cases with bucket handle tear and non-tear status of the involved meniscus on previous MRI scan

Case	Gender	Age (Years)	Side involved	Involved Meniscus	Type of ACL pathology	Time interval (Months)
1	Male	34	Left	Medial	Complete tear	6
2	Male	30	Left	Medial	Complete tear	35
3	Female	48	Right	Medial	Post reconstruction	16
4	Male	28	Left	Medial	Post reconstruction	28
5	Male	32	Right	Lateral	Post reconstruction	17
6	Male	18	Right	Medial	Post reconstruction	75
7	Male	21	Left	Medial	Post reconstruction	12
8	Male	23	Right	Medial	Post reconstruction	48
9	Male	24	Left	Medial	Complete tear	13

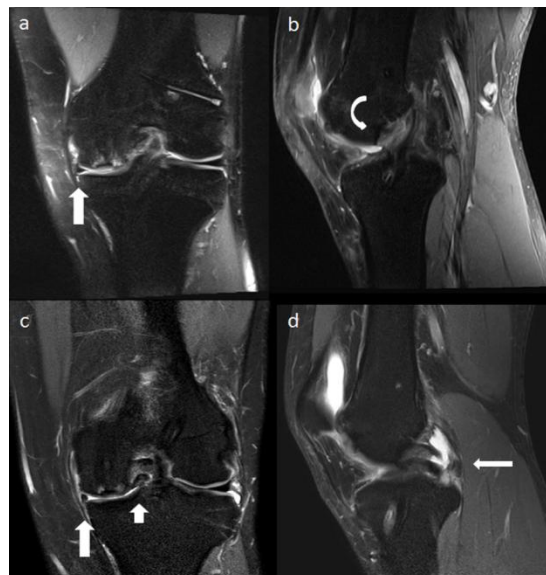


Figure 1. 28-year-old male patient with status post ACL-reconstruction. Coronal and sagittal proton density fat-suppression MRI images (a and b) show intact body of the medial meniscus (a, thick arrow) and the reconstructed anterior cruciate ligament (b, curved arrow). Coronal and sagittal proton density fat-suppression MRI images after 28 months interval (c and d) show the residual portion of the body of the medial meniscus (a, thick arrow), a displaced intercondylar fragment "in face" (c, short arrow) and "in profile" resulting in double posterior cruciate ligament sign (d, thin arrow).

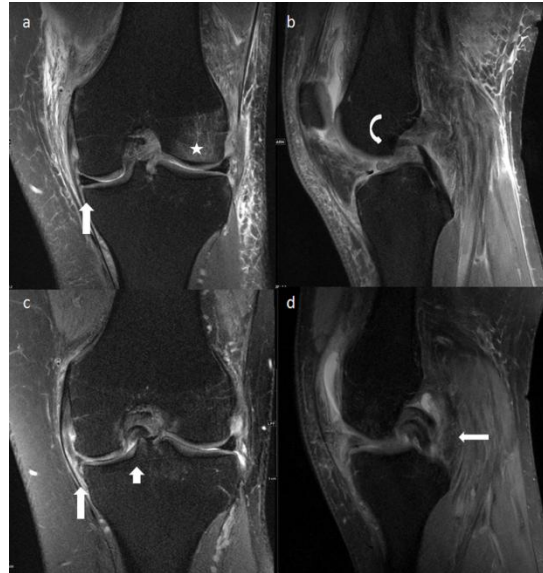


Figure 2. 34-year-old male patient presented post traumatic rupture of the anterior cruciate ligament. Coronal and sagittal proton density fat-suppression MRI images (a and b) show intact body of the medial meniscus (a, thick arrow), bony bruise at the lateral femoral condyle (star) and a ruptured anterior cruciate ligament (b, curved arrow). Coronal and sagittal proton density fat-suppression MRI images (c and d) after 6 months interval show the residual portion of the body of the medial meniscus (a, thick arrow), a displaced intercondylar fragment "in face" (c, short arrow) and "in profile" resulting in double posterior cruciate ligament sign (d, thin arrow).

DISCUSSION

The ACL is an important internal knee structure, which serves both mechanical and functional roles in knee stabilization [2].

Histologically it has been proven that the uninjured human ACL contains mechanoreceptors that detect changes in tension, speed, acceleration, direction of movement, and the position of the knee joint [3, 4, 5, 7]. It has been shown that direct stress on ACL would cause reflex hamstring activity which aid in the preservation of joint integrity, so damaged mechanoreceptors would cause loss of this reflex and contribute to the functional instability after ACL injuries [6].

The association between meniscal bucket handle and ACL tears has been previously reported, though most studies described a coincidental occurrence in knee trauma [8], which makes our study unique in studying the

temporal association between both structures using sequential MRI scans.

Disruption of the ACL can alter the proprioceptive function and dynamic stabilization of the knee joint. Loss of the neurophysiological protective reflex involving the ACL and hamstrings in patients with ACL deficient knee has been found to be a contributory factor in the decreased joint stability [6]. The association between ACL injury and proprioceptive function disruption has been confirmed in patients with unilateral ACL injury, who described a bilateral proprioceptive functional abnormality [4]. The potential negative consequences of an ACL injury even after ACL reconstruction resulting in alterations of the menisci was suggested by Kobayashi et al, which showed a high risk of developing definite meniscal tears after ACL reconstruction even in cases where no visible tear was found at initial

surgery in patients whom grade 3-lesions are identified in many MRI slices [9]. Furthermore a preventive role of ACL reconstruction has been described for progressive changes of the existing meniscal tears and will prevent secondary osteoarthritis [10].

In the current study we found that the presence of ACL pathology will end with later development of meniscal Bucket-handle tear even post restoration of its outline by previous ACL-reconstruction. Six cases had previous ACL-reconstruction with an intact graft outline at time of development of the meniscal injury. This result highlights the importance of mechanoreceptors in knee integrity apart from the mechanical role of the ACL represented by preserved ligamentous outline. Increasing researches have recommended preserve remnant of the ACL tissue at time of surgery instead of shaving it to aid in mechanoreceptor regeneration, which will result in better outcome and more stability of knee joint [11, 12, 13].

Limitations of the current study include the retrospective nature of the analysis, as well as the relatively small number of short listed patients having bucket handle tear on the newer scans with non-tear status on prior scans.

Further prospective studies post ACL-reconstruction are recommended in order to improve the understanding of the vital proprioceptive function of the ACL in affecting knee stability as well as its predisposing role for meniscal pathology. Also, future studies should assess the optimal way of ACL-reconstruction, in order to preserve as much as possible of its proprioceptive function to help in prevention of future development of a meniscal pathology.

CONCLUSION

In the current article we have sought MRI scans pre and post development of meniscal Bucket-handle tear in order to assess the main contributing factor in absence of knee trauma. We have concluded that the presence of ACL pathology is a crucial predisposing factor in development of meniscal tear including complete ACL tear or by status post ACL-reconstruction. This result supports the importance of proprioceptive function of ACL in stabilization of the knee joint that will remain altered by status post ACL-reconstruction; highlighting the necessity of close clinical and radiological follow-up of menisci post ACL-reconstruction by treating physicians.

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أمراض الرباط الصليبي الأمامي كعامل مؤثر لتمزقات مقبض الدلو في الغضروف الهلالي

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الملخص

الهدف: لاختبار ما إذا كان وجود خلل في الرباط الصليبي الأمامي عامل مؤثر لحدوث تمزق مقبض الدلو في الغضروف الهلالي.

المواد والأساليب: تمت مراجعة 3340 فحصاً متتالياً للتصوير بالرنين المغناطيسي للركبة بأثر رجعي لمركزين صحيين في الفترة ما بين تشرين الأول 2018 وأذار 2021 باستخدام أجهزة التصوير بالرنين المغناطيسي باستخدام المجال المغناطيسي واحد و نصف تسلا و ثلاثة تسلا. تم البحث عن جميع الحالات التي تعاني من تمزق مقبض الدلو في الغضروف الهلالي، تم فقط تضمين أولئك الذين لديهم فحوصات سابقة بالرنين المغناطيسي والتي تظهر غضروف هلاكي طبيعي.

النتائج: من خلال 3340 فحصاً بالرنين المغناطيسي، تم تحديد 36 حالة تعاني من تمزقات مقبض الدلو (30 منها تتعلق بالغضروف الهلالي الإنسي و 6 حالات تتعلق بالغضروف الهلالي الوحشي). 9 من أصل 36 حالة خضعت للتصوير بالرنين المغناطيسي سابقاً مع عدم وجود تمزق في الغضروف الهلالي المعني. و من المثير للاهتمام أن جميع هذه الحالات التسع أظهرت خللاً واضحاً في الرباط الصليبي الأمامي قبل حدوث تمزق مقبض الدلو في الغضروف الهلالي. تراوحت طبيعة أمراض الرباط الصليبي الأمامي المرتبطة بها من ثلاثة حالات لتمزق كامل و ست حالات لإعادة ترميم سابقة للتمزق. **الاستنتاج:** يمكن إظهار وجود ارتباط كبير بين أمراض الرباط الصليبي الأمامي والتطور اللاحق لتمزقات مقبض الدلو في الغضروف الهلالي. تسلط هذه النتيجة الضوء على أهمية الدور التحفيزي للرباط الصليبي الأمامي في الحفاظ على استقرار الركبة مما قد يؤدي إلى مزيد من إصابات الغضروف الهلالي الهيكلية وبالتالي التأكيد على ضرورة معالجة الغضروف الهلالي أثناء إعادة بناء الرباط الصليبي الأمامي وأهمية المتابعة السريرية و الإشعاعية.

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