

World Journal of *Orthopedics*

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INDEXING/ABSTRACTING

WJO is now abstracted and indexed in PubMed, PubMed Central, Emerging Sources Citation Index (Web of Science), Scopus, Reference Citation Analysis, China National Knowledge Infrastructure, China Science and Technology Journal Database, and Superstar Journals Database. The 2022 edition of Journal Citation Reports® cites the 2021 Journal Citation Indicator (JCI) for *WJO* as 0.62. The *WJO*'s CiteScore for 2021 is 2.4 and Scopus CiteScore rank 2021: Orthopedics and Sports Medicine is 139/284.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: *Ying-Yi Yuan*, Production Department Director: *Xiang Li*, Editorial Office Director: *Jin-Lai Wang*.

NAME OF JOURNAL

World Journal of Orthopedics

ISSN

ISSN 2218-5836 (online)

LAUNCH DATE

November 18, 2010

FREQUENCY

Monthly

EDITORS-IN-CHIEF

Massimiliano Leigheb

EDITORIAL BOARD MEMBERS

<http://www.wjgnet.com/2218-5836/editorialboard.htm>

PUBLICATION DATE

May 18, 2023

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INSTRUCTIONS TO AUTHORS

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<https://www.wjgnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>



Unhappy triad of the knee: What are the current concepts and opinions?

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Specialty type: Orthopedics

Provenance and peer review:

Invited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): A

Grade B (Very good): 0

Grade C (Good): C

Grade D (Fair): 0

Grade E (Poor): 0

P-Reviewer: Hamoongard M, Iran; Wang H, China

Received: December 26, 2022

Peer-review started: December 26, 2022

First decision: January 20, 2023

Revised: January 24, 2023

Accepted: April 6, 2023

Article in press: April 6, 2023

Published online: May 18, 2023



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Abstract

The association between injuries to the anterior cruciate ligament, medial collateral ligament, and medial meniscus (MM) has been known to orthopedic surgeons since 1936; O'Donoghue first used the term "unhappy triad" of the knee to describe this condition in 1950. Later studies revealed that involvement of the lateral meniscus is more common than MM in these cases, leading to a change in the definition. Recent studies have revealed that this triad may be primarily linked to knee anterolateral complex injuries. Although there is not a definite management protocol for this triad, we try to mention the most recent concepts about it in addition to expert opinions.

Key Words: Anterior cruciate ligament; Lateral meniscus; Anterolateral complex; Medial collateral ligament; Medial meniscus

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Core Tip: Traditionally, the anterior cruciate ligament (ACL), medial collateral ligament (MCL), and medial meniscus (MM) were thought to be the unhappy triad of the knee; however, lateral meniscus injuries are thought to be more common in association with ACL and MCL tears. Clinicians, radiologists, and orthopedic surgeons should be aware of the unhappy triad of the knee, while performing physical examinations, radiologic assessments, or knee arthroscopy. MCL spontaneous healing is possible in some cases with lower grades of tear; however, consideration of patient knee alignment and accuracy in MCL size for non-operative treatment decision-making is critical.

Citation: Hoveidaei AH, Sattarpour R, Dadgostar H, Razi S, Razi M. Unhappy triad of the knee: What are the current concepts and opinions? *World J Orthop* 2023; 14(5): 268-274

URL: <https://www.wjgnet.com/2218-5836/full/v14/i5/268.htm>

DOI: <https://dx.doi.org/10.5312/wjo.v14.i5.268>

INTRODUCTION

Overview: Medial meniscus or lateral meniscus, triad or tetrad?

Campbell first described a "combination" knee injury in 1936[1], which included injury to the anterior cruciate ligament (ACL), medial collateral ligament (MCL), and medial meniscus (MM), but the term "unhappy triad" was not used until O'Donoghue (1950) reported that about a quarter of all acute athletic knee injuries involve damage to the ACL, MCL, and MM. The MM was initially suspected as the main site of injury compared with lateral meniscal (LM) tears, and O'Donoghue found that only 3% of his sample of 33 patients had LM injuries[2,3]. However, arthroscopy studies showing the higher prevalence of LM tears shifted this dominance[4-6]. The definition of "medial meniscus injury" might have been misunderstood. Perhaps what O'Donoghue considered a MM injury was actually a capsular injury[7].

Extreme reflectoric muscle contractions brought on by rotational stress may result in chondromalacic lesions in the femoro-patellar joint, expanding the "unhappy triad" syndrome into the "unhappy tetrad" [8]. According to Müller *et al*[9], the fourth component of this tetrad is antero-lateral femoro-tibial ligament lesions. These are the distal posterior portions of the iliotibial tract that pass from the linea aspra to Gerdy's tubercle[10]. The jerk test, a type of pivot-shift test, can be used to assess anterolateral rotatory instability[11], and magnetic resonance imaging (MRI) has been shown to be useful[12]. According to some studies, anterolateral ligament abnormalities can increase the risk of a complete ACL tear and collateral ligament injuries[13,14]. Nonetheless, the MM is intact in these patients[15].

The injury pattern in the lateral compartment is usually stretching and hemorrhage of the antero-lateral capsule; Segond's fracture is less reported[10]. Ferretti *et al*[16] reported anterolateral capsule and ligament injuries in isolated ACL injuries. They also announced a new classification for this type of injury: Type I (stretching and bleeding in the anterolateral capsule alone), type II (stretching and bleeding from the front to the back), type III (complete tear of the anterolateral ligament [ALL]), and type IV (bone avulsion and Segond's fracture).

Recent studies have focused on the anterolateral femur-tibial ligament as a stabilizer of the knee's internal rotation and pivotal shift[17-19]. So, repairing these ligament injuries could help people who are getting their ACLs reconstructed.

Grading of MCL injuries is based on joint space widening by applying a valgus force on a 0-30° flexed knee[11,20,21]. Seventy-eight percent of MCL grade III injuries are associated with ACL injuries[22]. Shebourne and Posch proposed that parallel meniscus injuries have a relatively protective effect for higher-grade injuries[20,21].

In general, we can conclude that this triad should be defined as concomitant ACL, MCL, and MM/LM injuries, mostly associated with the anterolateral complex of the knee (Figure 1).

EPIDEMIOLOGY, MECHANISM OF INJURY, AND TYPE OF SPORTS

O'Donoghue reported an incidence as high as 25% of the "unhappy triad" in acute athletic knee injuries, and in a study of 22 patients with combined ACL and MCL injuries, it was found that 17 (or 77%) of them had an associated MM tear. However, later studies showed more dominant LM injuries. Shelbourne *et al*[23] found a 32-71% prevalence of LM injury while finding significantly lower rates of MM injury, even 0% in one of their study groups. The mechanism of injury in the unhappy knee triad is sudden valgus impact with external or internal rotation[16]. However, it is controversial whether the MCL or ACL is injured first[24,25].

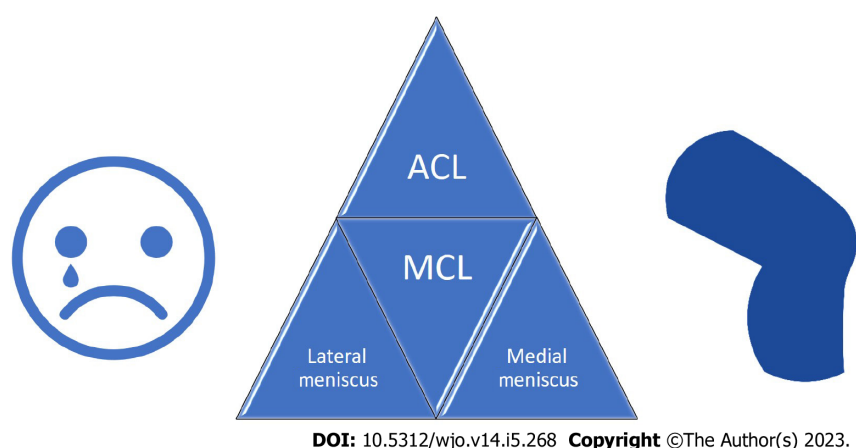


Figure 1 Unhappy triad of the knee. ACL: Anterior cruciate ligament; MCL: Medial collateral ligament.

This triad often occurs in contact and non-contact sports such as netball, basketball, soccer, skiing, and rugby[26,27]. A recent study, for example, discovered that the ACL was involved in all skiers' knee injuries[21], contrary to the popular belief about the MCL's dominance[28].

CLINICAL PRESENTATIONS

Immediately after trauma, the "unhappy triad" is observed. Swelling, hemorrhage, and serous effusion form after hours and accompany the meniscal and ligament injuries. However, in disrupted capsular injuries, effusion can be negated[29]. There is pain, impaired muscle control, edema, and reflex muscle inhibition in the acute phase. Through an accurate history and physical examination, we can determine injured structures. When rotating on a fixed knee, the majority of patients reported hearing a snapping click noise. Physical examinations, usually the Lachman test, pivot shift test, anterior drawer test, and valgus stress test, are positive, and patients have localized tenderness through the MCL[10,30]. Some patients have patellar instability because of a concomitant injury to the medial patellofemoral ligament and a superficial part of the MCL[27].

DIAGNOSTIC IMAGING TOOLS

X-ray images are not used often because of their low input except for insertion site bone avulsions and lower limb alignment. Using valgus stress X-ray, we can classify injuries into complete medial side tears and isolated high-grade MCL injuries by measuring the opening of medial tears[31]. Valgus stress X-ray results depend on patients' pain and muscular relaxation and could not be accurate in patients with higher degrees of immobility[32]. MRI and arthroscopy are considered accurate diagnostic tools for ACL injuries (around 90% sensitivity), but a blind arthroscopic approach could result in inappropriate treatment for 35% of patients[33,34]. We can use MRI to detect medial side and meniscus injuries, as well as cartilage injuries. As said, lateral side bruises and MRI findings can indicate a higher grade of injury in the medial compartment[27].

MANAGEMENT

Most cases require surgery and a recovery period of 6 to 9 mo. Reconstruction and repair of the ALL lesions should be considered to improve the control of rotational stability and future knee kinematics scores provided by ACL reconstruction. For high-risk patients, a combined ACL and ALL reconstruction improves rotational control and reduces the rate of re-rupture without increasing postoperative complication rates compared to an ACL-only reconstruction[35-39]. However, it needs further investigation for different degrees of injury[39,40]. Another important aspect of surgery is determining whether we can choose a conservative approach for MCL injuries in patients with an unhappy triad (tetrad). Treatment of MCL injuries evolved from an aggressive surgical approach[5,41] around 1960 to non-operative MCL treatment and early range of motion regarding the extra-articular healing ability of the MCL[42,43]. This healing potential is because of the enriched blood supply of the medial compartment of the knee. The Hughston grading system can be used to classify MCL injuries: Applying valgus stress opening in MCL tears between 1 and 5 mm is considered grade I; between 5 and

10 mm is considered grade II; and more than 10 mm is considered grade III[44]. In the original Hughston grading system, grades I and II injuries are named after incomplete MCL injuries, which are not present in the unhappy triad (tetrad). Several studies have highlighted that non-operative and operative managements of MCL injuries have similar satisfactory results, but these patients only had ACL injuries parallel to the MCL[27,45-47]. Patients with the unhappy knee triad (tetrad) with grades I and II MCL injuries can be treated conservatively (using injections and physiotherapy) with a delay in ACL reconstruction, allowing the MCL to heal by itself[48]. It is essential to note that early range of motion is recommended because of better collagen organization and healing outcomes[49]. Grade III injuries and competitive athletes are better treated surgically because of the risk of future ACL reconstruction failure, knee osteoarthritis, which has an increasing burden, and valgus knee instability [50,51]. The reason may be the disruption of menisco-tibial and menisco-femoral attachments during injuries involving deeper layers of the medial compartment (deep MCL). Even so, some studies show satisfactory outcomes in the non-operative management of isolated MCL grade III injuries, but confounding factors such as parallel ACL and meniscal injuries are not considered[52,53]. Meniscus repair is the other consideration that surgeons need to address. The MM is usually repaired because of its role in knee stability and protective effect on osteoarthritis[54].

PROGNOSIS

The unhappy triad can cause osteoarthritis in 50% of patients in 10-20 years due to intra-articular processes initiated by injury. Also, MCL injuries can cause long-term knee instability and increase susceptibility to meniscus injuries[26,55]. The osteoarthritis risk is not covered by anyone, with its pain and function impairment playing a major role in these patients, but the most important question is its rate in these patients and treatment outcomes. In Lundberg's study, 13% of patients with MCL injuries treated non-operatively showed radiographic signs of osteoarthritis[56]. Ochiai *et al*[57] found that in patients with injuries to the ACL, MCL, and LM, reconstruction of the ACL with or without the MCL and LM significantly improved the outcome. However, scores were higher in the group with a conservative approach to MCL. Physiotherapy, early range of motion, and limited weight bearing after reconstruction can improve knee mobility[58]. Using knee braces in high-grade injuries can help keep the knee in correct healing alignment, but it needs further study for long-term outcomes[59].

CONCLUSION

Even with recent studies, choosing between the conservative and operative approaches remains controversial among clinicians. In some cases, spontaneous healing of the MCL occurs without a surgical intervention[60]. Using some expert recommendations, we propose that patients with the unhappy triad of the knee who have varus alignment in the physical examination could undergo a conservative approach, meaning MCL non-operative treatment and ACL reconstruction surgery. These patients should be observed for complications like patellofemoral subluxation and pain. Although some previous studies have mentioned that low grade MCL tearing may not require surgical intervention, considering the fact that MCL tear size estimation without performing arthroscopy may not be accurate, we recommend operative treatment in patients with valgus and normal alignments.

FOOTNOTES

Author contributions: Hoveidaei AH and Sattarpour R contributed equally to the work. All authors contributed to the conception and design of the study; Hoveidaei AH, Sattarpour R, and Razi S drafted the article; Dadgostar H and Razi M made critical revisions related to the important intellectual content of the manuscript; all authors approved the final version of the article to be published.

Conflict-of-interest statement: All the authors declare that they have no conflict of interest with this work.

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S-Editor: Liu JH

L-Editor: Wang TQ

P-Editor: Zhao S

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