DOI: https://doi.org/10.54393/pjhs.v4i03.471

PAKISTAN JOURNAL OF HEALTH SCIENCES

https://thejas.com.pk/index.php/pjhs

Volume 4, Issue 3 (March 2023)

Systematic Review

Accuracy of Point-Of-Care Knee Sonography for Diagnosis of Traumatic Anterior / Posterior Cruciate Ligament Tears Taking Magnetic Resonance Imaging as Gold Standard: A Systematic Review and Meta-Analysis

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ARTICLE INFO

Key Words:

Anterior Cruciate Ligament(ACL), Posterior Cruciate Ligament(PCL), Knee Injury, Point-Of-Care Ultrasound(POCUS), Magnetic Resonance Imaging(MRI).

How to Cite:

Raheem, I., Manzoor, I., Rokhan, B., Iqbal, M., Fatima, Z., & Ali Khan, A. (2023). Accuracy of Point-Of-Care Knee Sonography for Diagnosis of Traumatic Anterior / Posterior Cruciate Ligament Tears Taking Magnetic Resonance Imaging as Gold Standard: A Systematic Review and Meta-Analysis: Accuracy of Point-Of-Care Knee Sonography. Pakistan Journal of Health Sciences, 4(03). https://doi.org/10.54393/pjhs.v4i03.471

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Received Date: 31st December, 2022
Acceptance Date: 27th March, 2023
Published Date: 31st March, 2023

ABSTRACT

Knee joint is among the all the body's joints that are much prone to sustains injuries. Injury to the knee ligaments followed by instability can lead to serious deformity. The diagnosis of ligament injuries is frequently performed by using magnetic resonance imaging (MRI), but the use of ultrasonography remains controversial. This article reviews the current literature regarding the viability of point-of-care knee ultrasonography (POCUS) in comparison to knee magnetic resonance imaging (MRI) for the diagnosis of anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) injuries in those individuals who have experienced sudden knee trauma. The data span from 2000 to 2022 was used for the electronic database search (PubMed, Science Direct, Google Scholar). The systematic review included all studies that evaluated the diagnostic efficacy of ultrasound (U/S) compared to MRI as the gold standard and were completely available in English. The meta-analysis reviewing the efficacy of MSK-POCUS for anterior and posterior cruciate ligament injuries includes 30 papers. The overall ultrasonography sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were 76.02%, 92.77%, 92.25%, and 81.91% (95% CI), respectively. By assuring MRI as the gold standard in the diagnosis of ACL and PCL injuries, Point-of-care ultrasound (POCUS) reveals high accuracy. In individuals who have sustained acute knee injuries, the results of POCUS imaging might be serve to provide an initial diagnosis for additional pre-operative work-up.

INTRODUCTION

Anterior and posterior cruciate ligament tears are common injuries of the knee and a common problem in the casualty of hospitals, occurring because of sports activities , motor vehicle collision, slip down, and fall with the proportion of 67.7%, 19.4%, 9.7%, and 3.2% respectively [1, 2]. The ACL, the knee's primary stabilizing ligament, protects the tibia from rotating in an anterior or medial direction [3]. The Posterior cruciate ligament is another essential ligament that supporting the knee, restricts the tibia from laterally and posteriorly rotation [4]. The ACL is the knee ligament that gets damaged the most commonly with the incidence of greater than 2 million people world-wide sustain an ACL injury each year [5]. Posterior cruciate ligament (PCL) rupture is a kind of rare consequence of traumatic knee ligament injury, accounting for 3-23% of all acute knee ligament injuries [6, 7]. In acute phase of trauma, the diagnostic accuracy of ligamentous injury is frequently low [8]. In general, early diagnosis of anterior and posterior

DOI: https://doi.org/10.54393/pjhs.v4i03.471

cruciate ligament tears is generally made thorough history of patient and clinical examination, but these examinations have shown fairly low sensitivity and high variability resulting in a subsequent delay in diagnosis and an increased probability of severe cartilage damage , deformity and early onset osteoarthritis due to instability specially in youth population [2, 9]. The gold standard for imaging the knee injuries is magnetic resonance imaging (MRI), but routine MRI is not cost-effective as an initial diagnosis and is not readily available in emergency departments [3]. On the other hand, anterior and posterior cruciate ligament injuries can be diagnosed by stress radiography. Conferring to a review article, stress radiography for diagnosing ACL rupture demonstrate less sensitivity (43% -100%) and inconstant specificity (76% - 100%) and similar variability (sensitivity 88-100% and specificity 77-100%) in diagnosing PCL injuries. Furthermore, standardization of the degree of pressure applied during stress radiography to assess the anterior and posterior knee stability has not been established [10, 11]. Point-of-care ultrasound (POCUS) is progressively known in musculoskeletal domain for its investigative worth in the emergency department owing to its precision and ability to image in real-time. By keeping MRI as the gold standard, POCUS demonstrated acceptable sensitivity (92.2%), specificity (95.9%), and accuracy (94.4%) for anterior and posterior cruciate ligament tears, making ultrasound a tool of care, suggest that they can guide clinicians in the management of patients who have had injuries to the knee. So far, POCUS has been used to diagnose wrist, elbow, foot and ankle injuries [2]. Against this contextual, it can be envisioned that Point-of-care knee ultrasound is affordable and quick early diagnostic option that can lead to recommendations for further MRI scanning for acute knee trauma patients to diagnose anterior and posterior cruciate ligament rupture. An un-delayed and accurate diagnosis allows for appropriate treatment. Additionally, POCUS may be useful for patients with claustrophobia and those with artificial knee joints. So, using MRI as the gold standard diagnostic modality, this study's goal was to assess the viability of point-of-care knee ultrasonography (POCUS) for the diagnosis of anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) injuries in those individuals who have experienced sudden knee trauma

METHODS

Studies that assessed the use of point-of-care ultrasound to diagnose ACL or PCL injuries using MRI or arthroscopy as gold standards and that either directly or through indirect methods presented the original data, analysis was performed to assess the sensitivities, specificities, positive predictive value, and negative predictive value. Studies that had already been published with a smaller sample size (less than 20 cases), inconclusive research, reviews studies, case studies, systematic reviews, and meta-analyses were all subject to our exclusion criteria. We retrieved and identified all relevant literature from Google Scholar. Medical Subject Headings and complimentary words were used in the search, which were restricted to English publications. Two authors each independently read the studies and abstracts. The findings of processes that obviously did not fulfil the inclusion criteria, along with the duplicate research, were excluded. To ascertain whether the preliminary included studies fulfilled all of the inclusion requirements, the investigators studied the whole texts of the papers. The outcomes of the included studies were double-checked by the two examiners. All of the disagreements were discussed with and handled by a third examiner. Two authors came up with the following criteria for information extraction after incorporating the qualified studies: the first author's last name, publication year, Journal of publication, number of patients, disease characteristics, country of the study, PPV, NPV, sensitivity and specificity.

RESULTS

Figure 1 depicts the characteristics of the selection procedure. We found a total of 199 publications using the search method, including 189 from Google Scholar and Ten from Science Direct.

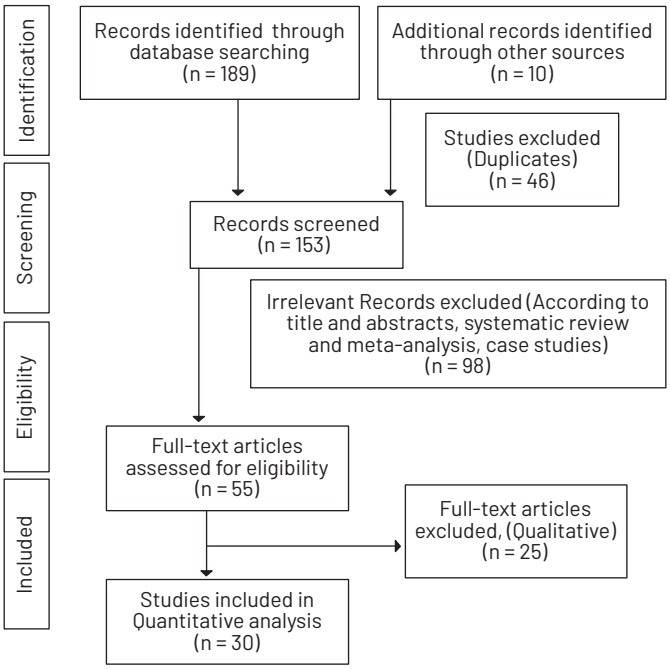

Figure 1: Flow Chart of Selected Study Collection Process

Using "EndNote X9" 46 duplicate papers were eliminated, leaving 153 publications. On the basis of the title and abstract, 98 studies-including systematic reviews and/or

DOI: https://doi.org/10.54393/pjhs.v4i03.471

meta-analyses and case reports-were eliminated. Complete reviews were conducted on the remaining 55 papers, 25 of which were discarded because of the missing quantitative table data in complete texts articles. Finally, thirty articles were chosen. (Table 1), from which 16 studies were regarding the precision of POCUS for ACL tears, 11 studies for PCL tears and 03 articles for both ACL and PCL tears. The summary estimates of sensitivity, specificity, PPV, NPV of ultrasound were 80.16%, 89.56%, 94.48% and 75.95% (95 % CI) respectively, for ACL tears; 73.72%, 96.08%, 84.86% and 91.3% (95% CI) respectively, for PCL tears; 62.63%, 96.66%, 95.6%, and 85.7% (95 % CI) respectively, for combined ACL/PCL tears.

Table 1: Detailed characteristics of selected studies

Sr #	Author (year)	Journal	Country	Sample size	Disease	Sensitivity	Specificity	PPV	NPV
1	Adil Qayyum et al.[12]	Pak Armed Forces Med Journal	Multan	59	ACL Tear	85.40%	85.40%	97.60%	58.80%
2	Ken Mautner, MD et al.[13]	Journal of Ultrasound & Medicine	USA	69	ACL Tear	84.90%	93.80%	91.80%	N/A
3	Barzin M et al.[14]	Journal of Gorgan University of Medical Sciences	Iran	73	ACL Tear	65%	100%	100%	70.21%
4	Gilani SA et al.[15]	Ultrasound in Medicine and Biology	Pakistan	192	PCL Tear	100%	98.90%	N/A	N/A
5	Piotr Grzelak et al.[16]	Indian Journal of Orthopaedics	Poland	83	ACL Tear	91.90%	95.60%	N/A	N/A
6	Anca Gabriela Stoianov et al.[17]	Journal of Clinical Medicine	Romania	23	ACL Tear	95.45%	N/A	N/A	N/A
7	H.-G. Palm et al.[18]	The Knee	Germany	60	ACL Tear	97%	87.50%	N/A	N/A
8	Sun Hwa Lee et al: [19]	American Journal of Emergency Medicine	Korea	62	ACL,PCL Tear	90.60%	90.00%	91.20%	96.40%
9	Manon Breukers et al.[20]	BMJ Open Sport & Exercise Medicine	Netherlands	247	ACL Tear	88%	82%	79.00%	90%
10	Lars Peter Skovgaard Larsen et al [21]	European Journal of Ultrasound	Ireland	62	ACL Tear	88%	98%	93%	96%
11	Chung-Yuan Wang et al.[22]	Journal of Medical Ultrasound	Taiwan	35	PCL Tea	83.30%	87.00%	N/A	N/A
12	Lin-Yi Wang et al.[7]	Knee Surgery Sports Traumatology Arthroscopy	Taiwan	330	PCL Tear	90.60%	86.70%	87.90%	82.40%
13	Sally M.A. Hussien et al.[23]	Medical Journal of Cairo University	Egypt	30	ACL & PCL	14.30%	100%	N/A	N/A
14	Amandeep Singh et al.[24]	International Journal of Anatomy Radiology and Surgery	India	60	ACL Tear	78.20%	78.30%	N/A	N/A
15	Ptasznik et al.[25]	American Journal of Roentgenology	Australia	37	ACL Tear	91%	100%	100%	63%
16	Attya M.S. et al. [26]	AL-AZHAR ASSIUT MEDICAL JOURNAL	Egypt	60	PCL Tear	50%	96.1%	66.60%	92.50%
17	Cho et al.[27]	The Radiology	Korea	35	PCL Tear	100%	100%	N/A	N/A
18	Atul Pratap Singh et al.[28]	Journal of Diagnostic Medical Sonography	India	103	ACL Tear	15%	95%	N/A	N/A
19	Bhanupriya Singh et al.[29]	IOSR Journal of Dental and Medical Sciences	India	50	PCL Tear	75%	93.48%	N/A	N/A
20	Singh A.P et al..[28]	Journal of Diagnostic Medical Sonography	India	103	PCL Tear	45%	99%	N/A	N/A
21	Fuchs,S. et al.[30]	Ultrasound in Medicine and Biology	Germany	193	ACL Tear	90%	50%	N/A	N/A
22	Sharma VK et al. [31]	International Journal of Medical Research Professionals	India	100	PCL Tear	42.86%	100%	N/A	N/A
23	J. K. Sekiya et al. [32]	The Journal of Arthroscopic and Related Surgery	U.S.A	16	ACL & PCL	83%	100%	100%	75%
24	Palle Lalitha et al. [33]	Pakistan Journal of Radiology	India	110	PCL Tear	90.90%	100%	100%	99%
25	Zia Faruqui et al. [34]	Acta orthopaedica Belgica	Saudi Arabia	81	ACL Tear	75%	100%	100%	77.70%
26	SAGEER P. K et al. [35]	Kerala Journal of Orthopaedics	India	35	PCL Tear	100%	100%	N/A	N/A
27	S. K. Venkatesh Gupta et al. [36]	Open Journal of Orthopedics	India	50	ACL Tear	74.20%	100%	N/A	N/A
28	Mohammad S. A. Attya et al. [26]	Al-Azhar Assiut Medical Journal	Egypt	60	ACL Tear	81.20%	84%	N/A	N/A
29	Singh. B et al..[29]	International Organization of Scientific Research Journal of Dental and Medical Sciences	India	50	ACL Tear	82.35%	93.94%	N/A	N/A
30	Maheshwari et al.[37]	Journal of Medical Sciences and Health	India	50	PCL Tear	50%	97.6%	80%	91.1%

DISCUSSION

In this paper we evaluated the performance of ultrasound diagnostic techniques; it is well known that clinical examination of acutely injured knees is notoriously unreliable due to pain and inadequate muscle relaxation. Early evaluation of ligament laxity resulted in false-negative outcomes in 12–62% of cases, leading to the introduction of alternative non-invasive diagnostic modalities such as MRI and MSK-US [12]. POCUS has several advantages compared to other imaging methods. First, as compared to different imaging modalities like MRI, Point-of-care ultrasound particularly suitable for frequent and immediate examinations. Second, POCUS promises

DOI: https://doi.org/10.54393/pjhs.v4i03.471

not only to diagnose torn ligaments, but also to distinguish other musculoskeletal disorders in knee trauma patients [13]. Third, as in our study, POCUS can be used to compare injured and uninjured knees in real time. Fourth, functional (dynamic) ultrasound may also be performed [14, 15]. Suzuki et al. confirmed that the anterior cruciate ligament can be visualized directly on ultrasound. However, indirect or dynamic techniques are often used in conjunction with ultrasound to diagnose an ACL tear [38]. A recent review article counseled that the ACL and PCL lie deep with inside the joint and are only partially visible with no cortical attachments. In this setting, direct visualization of ligaments is possible by knee sonography and indirect signs such as joint hemorrhage and hematoma with ultrasound sensitivity 88%, specificity 98%, PPV and NPV of 93% and 96%. In mixed populations, ACL ruptures account for only 17% of joint bleeds, but account for more than 70% of acute joint bleeds in young athletes [12, 17]. Magnetic resonance imaging is an effective imaging technique for the definitive diagnosis of ACL tear. For complete anterior cruciate ligament rupture, MRI showed sensitivity and specificity of 87% and 93%, respectively. However, MRI finding of a partial ACL tear appears difficult, with sensitivities ranging from 40-75% and specificities from 62-89%. The Hoffa's fat pad can be viewed as a hypoechoic wedge-shaped structure, whereas the normal ACL can be seen as a hypoechoic band with an age-related hyperechoic pattern (see Figure 2.A). During passive knee extension/flexion maneuvers in dynamic tests, the unaffected ACL moves upward, sandwiching the Hoffa fat pad between the patellar tendon and anterior cruciate ligament (dynamic direct sign). The Hoffa fatty layer and anterior cruciate ligament do not move upward in the case of a complete tear of the ACL, although scar tissue and minimal Hoffa fat pad upward movement are seen in the case of a partial tear of the ACL. A review paper by Wang J et al., 2018 demonstrated the sonographic diagnostic accuracy in detecting complete rupture of the anterior cruciate ligament, showing 90% sensitivity and 97% specificity [5]. This means that the ultrasound is an efficient test for assessing a complete ACL tear, but since 85% of partial ACL tears were missed by the US, so It may not an adequate test (sensitivity 15%) [5]. Subsequently, in 2019, In a clinical situation where ultrasonography is performed as an initial diagnostic screening test, retrospective observational research involving 247 patients was done to show the diagnostic efficacy of dynamic ultrasound in diagnosing partial and complete rupture of the anterior cruciate ligament. They discovered that a complete ACL tear was more sensitive than for a partial ACL tear (79 vs. 52%). When comparison is made between these two studies, it's found low sensitivity (79% vs. 90%) and specificity (89 vs. 97%) for complete ligament tears. However, it was found to be more sensitive to partial torn (52 vs 15%). MRI allows non-invasive visualization of PCL and therefore plays an important role in detection and evaluation of traumatic PCL lesions. In terms of detecting PCL tears, MRI has been shown to have a sensitivity of 94% and a specificity of 99%. A normal PCL appears as a hypoechoic crescent-shaped structure with a distinct fiber pattern that is easily distinguishable from hyperechoic fat (see Figure 2.B).

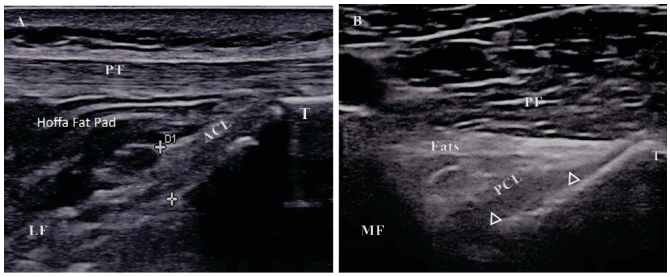

Figure 2. Point-of-care ultrasound examinations of the nontraumatic knee. (A, B) Long-axis view of the normal anterior cruciate ligament (cursors, A) and posterior cruciate ligament (arrowheads, B). Continuity, with well-defined hypoechoic bands, is well preserved. PT = patella Tendon; T = tibia; LF = lateral femoral condyle; MF = medial femoral condyle; PF = Popliteal Fossa.

High-resolution sonographic Criteria used to define the presence of acute posterior cruciate ligament tear: (1) marked hypo echogenicity with non-visualization of normal fiber pattern, (2) hypertrophy, (3) ill-defined irregular superficial margins and (4) ill-defined posterior margins [6]. According to Wang, et al., ultrasound has an accuracy of 85.7%, a specificity of 87%, and a sensitivity of 83.3% with MRI as the gold standard, to detect posterior cruciate ligament rupture. Ultrasonography therefore appears to be a reliable diagnostic tool for detecting posterior cruciate ligament rupture. Posterior Cruciate ligament tears were found in only 13 of 35 patients, so further analysis of the location and type of tear (complete or partial) was not possible [5]. Lee and Yun (2017) presented a case report of ACL and PCL injuries by using POCUS in the emergency department in an athlete, whose results could be used as threshold criteria to diagnose tear of the knee's cruciate ligaments. A 19-year-old lady presented to the emergency department with acute-onset severe pain primarily localized to the anterior and posterior aspect of the left knee. Physical examination tests to assess knee instability such as, "anterior drawer", "posterior drawer", "Lachman," "pivot shift," and "quadriceps active" testing cannot be performed due to severe tenderness, pain and mild swelling. A linear array ultrasonic transducer with a frequency of 9-12 MHz was used. For comparison, the right knee was examined first. The knee was placed in a flexed

DOI: https://doi.org/10.54393/pjhs.v4i03.471

position about 120-150 degrees. The patient was positioned in the supine posture lying on the back for ACL evaluation and in the prone position for PCL evaluation. Ultrasonographic examination of the left knee showed a rupture where the tibial ACL attaches with retraction of the torn split ends, consistent with a complete ACL tear as seen in Figure 3.A. Moreover, the images showed partial interruption at mid site of PCL without retraction, consistent with incomplete/partial PCL tear, same findings of partial ACL tear could appear (Figure 3.B). The patient was admitted to the hospital and underwent a preoperative knee MRI [1]

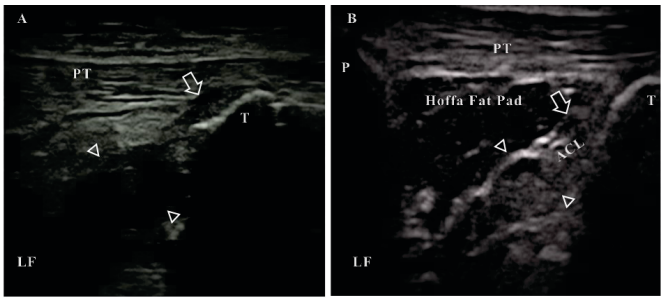

Figure 3. POCUS examinations of the complete and partial ACL tear. Long-axis view of the Complete tear of anterior cruciate ligament (ACL) (A) and partial tear of ACL (B). Complete disruption at the proximal ACL discontinuity between femoral attachment site (arrowheads) of the ACL and distal torn retracted fragments (open arrows, A) is observed, indicating complete ACL rupture. In addition, partial disruption (arrowheads, B) of the continuity at the mid-ACL without retraction is observed, indicating partial ACL rupture. LF = lateral femoral condyle; T = tibia; P = patella; MF = medial femoral condyle; PT = patella tendon.

Kim, D.H et al. demonstrated the Ultrasound criteria for diagnosing ACL/PCL rupture include discontinuities and indirect signs (anechoic space at femoral ACL insertion site, thickening of the ACL/PCL, and irregular posterior margin). Indirect ultrasound criteria are more sensitive (90%) than direct criteria (70% and 60%) in diagnosing acute ACL/PCL rupture and specificity (80%) are excellent. A hematoma and echo-poor space presents the characteristic sonographic criteria [39]. MRI signs of acute complete ACL rupture include non-visualization of the ACL; discontinuities of bands with abnormally increased T1 and T2 signals due to edema and hemorrhage; morphological abnormalities such as thickened, wavy, or retracted appearance; and an angle to the horizontal plane. In acute partial tears, the ACL bundle appears intact, but the ligament thickens with a high intensity signal of T2. When the PCL is completely ruptured, the fiber becomes discontinuous and the liquid signal passes completely through the fiber. Partial ruptures thicken the PCL and increase signal. Some of PCL fibers still appear intact, some appear discontinuous [40].

CONCLUSIONS

In conclusion, Knee POCUS (Point-of-care ultrasound) is affordable and quick early diagnostic option that can lead to recommendations for further MRI studies for diagnosing anterior and posterior cruciate ligament tears with acute knee traumatic patients. By un-delayed and accurate diagnosis, proper management could be possible. Furthermore, POCUS could be useful in claustrophobic patients and for those who had knee implants.

Conflicts of Interest

The authors declare no conflict of interest

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article

REFERENCES

[1] Lee SH and Yun SJ. Diagnosis of simultaneous acute ruptures of the anterior cruciate ligament and posterior cruciate ligament using point-of-care ultrasound in the emergency department. The Journal of Emergency Medicine. 2018 Mar; 54(3): 335-8. doi: 10.1016/j.jemermed.2017.11.014

[2] Lee SH and Yun SJ. Feasibility of point-of-care knee ultrasonography for diagnosing anterior cruciate and posterior cruciate ligament tears in the ED. The American Journal of Emergency Medicine. 2020 Feb; 38(2): 237-42. doi: 10.1016/j.ajem.2019.04.040

[3] Knutson T, Bothwell J, Durbin R. Evaluation and management of traumatic knee injuries in the emergency department. Emergency Medicine Clinics. 2015 May; 33(2): 345-62. doi: 10.1016/j.emc.2014.12.007

[4] Tintinalli J. Tintinallis emergency medicine A comprehensive study guide: McGraw-Hill Education; 2015.

[5] Wang J, Wu H, Dong F, Li B, Wei Z, Peng Q, Dong D, et al. The role of ultrasonography in the diagnosis of anterior cruciate ligament injury: a systematic review and meta-analysis. European journal of sport science. 2018 Apr; 18(4): 579-86. doi: 10.1080/17461391.2018.1436196

[6] Sorrentino F, Iovane A, Nicosia A, Candela F, Midiri M, Lagalla R. Role of high-resolution ultrasonography without and with real-time spatial compound imaging in evaluating the injured posterior cruciate ligament: preliminary study. La radiologia medica. 2009 Mar; 114(2): 312-20. doi: 10.1007/s11547-008-0355-5

[7] Wang LY, Yang TH, Huang YC, Chou WY, Huang CC, Wang CJ. Evaluating posterior cruciate ligament injury by using two-dimensional ultrasonography and

DOI: https://doi.org/10.54393/pjhs.v4i03.471

sonoelastography. Knee Surgery, Sports Traumatology, Arthroscopy. 2017 Oct; 25(10): 3108-15. doi: 10.1007/s00167-016-4139-5

[8] Phelan N, Rowland P, Galvin R, O'Byrne JM. A systematic review and meta-analysis of the diagnostic accuracy of MRI for suspected ACL and meniscal tears of the knee. Journal of Knee Surgery, Sports Traumatology, Arthroscopy.2016; 24(5): 1525-39. doi: 10.1007/s00167-015-3861-8

[9] Beyzadeoglu T, Demirel M, Circi E. Simultaneous ACL-PCL reconstructions with high tibial osteotomy: salvage for an unstable arthritic knee. Case Reports. 2016 Jan; 2016. doi: 10.1136/bcr-2015-210053

[10] Perera NS, Joel J, Bunola JA. Anterior cruciate ligament rupture: delay to diagnosis. Injury. 2013 Dec; 44(12): 1862-5. doi: 10.1016/j.injury.2013.07.024

[11] James EW, Williams BT, LaPrade RF. Stress radiography for the diagnosis of knee ligament injuries: a systematic review. Clinical Orthopaedics and Related Research. 2014 Sep; 472(9): 2644-57. doi: 10.1007/s11999-014-3470-8

[12] Qayyum A, Adil R, Amin Z, Azhar A, Aziz T, Khan S. Accuracy Of Ultrasound In Detection Of Anterior Cruciate Ligament Tear Of Knee In Ccompaison To Magnetic Resonance Imaging. Pakistan Armed Forces Medical Journal. 2019 Dec; 69(6): 1315-9.

[13] Mautner K, Sussman WI, Nanos K, Blazuk J, Brigham C, Sarros E. Validity of indirect ultrasound findings in acute anterior cruciate ligament ruptures. Journal of Ultrasound in Medicine. 2019 Jul; 38(7): 1685-92. doi: 10.1002/jum.14853

[14] Barzin M, Abdi R, Golmohammadi H. Diagnostic accuracy of ultrasonography in comparison with magnetic resonance imaging in patients with knee trauma. Journal of Gorgan University of Medical Sciences. 2012 Sep; 14(3): 92-7.

[15] Gilani SA. 2205: Ultrasonographic estimation of posterior cruciate ligament. Ultrasound in Medicine and Biology. 2006 May; 32(5): P129-30. doi: 10.1016/j.ultrasmedbio.2006.02.498

[16] Grzelak P, Podgórski MT, Stefańczyk L, Domżalski M. Ultrasonographic test for complete anterior cruciate ligament injury. Indian journal of orthopaedics. 2015 Apr; 49: 143-9. doi: 10.4103/0019-5413.152432

[17] Stoianov AG, Pătrașcu JM, Hogea BG, Andor B, Mișcă LC, Florescu S, et al. Dynamic Ultrasound Assessment of the Anterior Tibial Translation for Anterior Cruciate Ligament Tears Diagnostic. Journal of Clinical Medicine. 2022 Apr; 11(8): 2152. doi: 10.3390/jcm11082152

[18] Palm H-G, Bergenthal G, Ehry P, Schwarz W, Schmidt R, Friemert B. Functional ultrasonography in the diagnosis of acute anterior cruciate ligament injuries: a field study.The knee 2009; 16(6): 441-6. doi: 10.1016/j.knee.2009.04.012

[19] Lee SH and Yun SJ. Efficiency of knee ultrasound for diagnosing anterior cruciate ligament and posterior cruciate ligament injuries: a systematic review and meta-analysis. Skeletal Radiology. 2019 Oct; 48: 1599-610. doi: 10.1007/s00256-019-03225-w

[20] Breukers M, Haase D, Konijnenberg S, Klos TV, Dinant GJ, Ottenheijm RP. Diagnostic accuracy of dynamic ultrasound imaging in partial and complete anterior cruciate ligament tears: a retrospective study in 247 patients. BMJ Open Sport & Exercise Medicine. 2019 Dec; 5(1): e000605. doi: 10.1136/bmjsem-2019-000605

[21] Larsen LP and Rasmussen OS. Diagnosis of acute rupture of the anterior cruciate ligament of the knee by sonography. European journal of ultrasound. 2000 Dec; 12(2): 163-7. doi: 10.1016/S0929-8266(00)00109-9

[22] Wang CY, Shih TT, Wang HK, Chiu YN, Wang TG. The accuracy of ultrasonographic examination of injured posterior cruciate ligament. Journal of Medical Ultrasound. 2009 Jan; 17(4): 187-92. doi: 10.1016/S0929-6441(09)60127-2

[23] Marwa IF, Sally MH, Ali AM. Role of ultrasound in assessment of menisco-ligamentous injuries of knee joint in comparison with magnetic resonance imaging. The Medical Journal of Cairo University. 2019 Dec; 87(12): 4571-7. doi: 10.21608/mjcu.2019.80706

[24] Singh A, Mangat I, Thukral C, Gupta K. Diagnostic accuracy of ultrasonography in evaluation of knee injuries with magnetic resonance imaging correlation. International journal of anatomy radiology & surgery. 2018; 7(1): 50-5.

[25] Ptasznik R, Feller J, Bartlett J, Fitt G, Mitchell A, Hennessy O. The value of sonography in the diagnosis of traumatic rupture of the anterior cruciate ligament of the knee. AJR. American journal of roentgenology. 1995 Jun; 164(6): 1461-3. doi: 10.2214/ajr.164.6.7754893

[26] Attya MS. Evaluation of role of non ionized radiology tools in knee soft tissue injuries. Al-Azhar Assiut Medical Journal. 2015 Jul; 13(1).

[27] Cho KH, Lee DC, Chhem RK, Kim SD, Bouffard JA, Cardinal E, et al. Normal and acutely torn posterior cruciate ligament of the knee at US evaluation: preliminary experience. Radiology. 2001 May; 219(2): 375-80. doi: 10.1148/radiology.219.2.r01ma22375

[28] Singh AP, Chandak S, Agarwal A, Malhotra A, Jain A, Khan AA. Utility of high-resolution sonography for

DOI: https://doi.org/10.54393/pjhs.v4i03.471

evaluation of knee joint pathologies as a screening tool. Journal of Diagnostic Medical Sonography. 2021 Nov; 37(6): 556-67. doi: 10.1177/87564793211035773

[29] Singh B, Pawar KN, Kachewar S, Ghule SS, Lakhkar DL. Evaluation of knee joint by ultrasound and MRI. IOSR J Dent Med Sci. 2016; 15(10): 122-31.

[30] Fuchs S and Chylarecki C. Sonographic evaluation of ACL rupture signs compared to arthroscopic findings in acutely injured knees. Ultrasound in medicine & biology. 2002 Feb; 28(2): 149-54. doi: 10.1016/S0301-5629(01)00507-5

[31] Sharma VK and Grewal TS. Sonographic evaluation of pathologies of knee joint with MRI correlation. 2020

[32] Sekiya JK, Swaringen JC, Wojtys EM, Jacobson JA. Diagnostic ultrasound evaluation of posterolateral corner knee injuries. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2010 Apr; 26(4): 494-9. doi: 10.1016/j.arthro.2009.08.023

[33] Lalitha P, Reddy MC, Reddy KJ, Kumari V. Ultrasound evaluation of normal and abnormal posterior cruciate ligament-A prospective study. Pakistan Journal of Radiology. 2016 Jul; 20(3).

[34] Zaka KH, Faruqui Z, Ogyunbiyi O, Rosset G, Iqbal J. Ultrasound assessment of internal derangement of the knee. Acta orthopaedica belgica. 2006; 72(1): 72-6.

[35] Sageer Pk Sa, Mohan R, Ts G. Diagnostic Test Evaluation Of Ultra Sound And Mri Compared To Arthroscopy In Clinically Positive Meniscal And Ligamentous Injuries Of Knee. Kerala Journal Of Orthopaedics. 2015 Jan; 28(1): 37-41.

[36] Gupta SV and Aditya SS. Is Ultrasound Effective in Diagnosing Internal Derangements of the Knee?. Open Journal of Orthopedics. 2013 Dec; 3(08): 321-4. doi: 10.4236/ojo.2013.38059

[37] Maheshwari M, Yadav PK, Jain S, Batham IK, Gupta A, Swaika S. Imaging of Knee Joint Pathologies: A Comparative Study of Ultrasound and Magnetic Resonance Imaging. Journal of Medical Sciences. 2022 Sep; 8(3): 222-8. doi: 10.46347/jmsh.v8i3.22.168

[38] Suzuki S, Kasahara K, Futami T, Iwasaki R, Ueo T, Yamamuro T. Ultrasound diagnosis of pathology of the anterior and posterior cruciate ligaments of the