ORIGINAL ARTICLE

PLAIN RADIOGRAPHY & MRI CORRELATION IN SOFT TISSUE INJURIES OF THE KNEE JOINT

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ABSTRACT

Introduction: The primary aim is to identify and establish new signs in plain radiography of the knee joint that could indicate soft tissue abnormalities that are established on Magnetic Resonance Imaging (MRI). To correlate the plain radiographic features to that of the MRI findings which is the gold standard in the evaluation of the knee disorders.

Methodology: A prospective cross sectional study was done on a total of 50 patients including both the sexes and of all age groups who presented with knee joint pain and subsequently underwent plain radiographic evaluation followed by MRI of the knee joint. The data is analyzed and the findings on plain radiographs correlated with that of MRI.

Results: The most common soft tissue injuries as identified on MRI of the knee joint were that of Anterior Cruciate Ligament (ACL) and medial meniscus (MM). Knee joint effusion was found to be a common occurrence in cases of trauma. These findings were also identified on plain radiographs.

Conclusion: Sign complexes on plain radiograph with regard to joint space, inter condylar region of tibia, tibial plateaus, soft tissue planes at the tibio femoral joint, supra and infra patellar regions on lateral radiograms, and calcifications in soft tissue planes indicate various soft tissue injuries of the knee as detected and confirmed on MRI. Thus plain radiograph stands as a primary imaging modality in diagnosing not only the osseous abnormalities of the knee joint but also soft tissue abnormalities in comparison to MRI.

Keywords: Soft tissue knee injuries, Plain radiography, Sign complexes, MRI Knee joint, ACL injury.

INTRODUCTION

Knee joint is particularly vulnerable to injury because of its unique architectural arrangement of bony, muscular, ligamentous, and meniscal structures and its key role in ambulation and support.[1] Radiography is the first step in the evaluation of the knee joint disorders as it is universally available, quick and inexpensive and can yield many diagnostic clues.[2] It can readily reveal fractures, osteochondral defects, bony lesions, joint effusions and joint space narrowing and bone mal-alignment.[3]. However, some fractures and most soft tissue injuries about the knee have subtle radiographic findings and may be difficult to detect even with optimal radiographic view.[4] Due to certain limitations of the plain radiography in evaluation the soft tissues, it is superseded by other imaging modality like the MRI.[5] Radiographic features of several subtle, yet detectable knee injuries are studied, with a goal to emphasize the analysis of plain radiographic findings and correlation of radiographic results with those of magnetic resonance imaging (MRI).[6] In the recent days MRI is the gold standard in imaging soft tissues of the knee. It provides high resolution images with detailed information concerning the bone marrow, cortex, cartilage, menisci, ligaments, tendons and surrounding synovium.[7] It enables multiplanar imaging and many a times obviates the need for invasive procedures like arthroscopy.[8] Therefore the objectives of the present study was to identify the plain radiographic signs and correlate with MRI findings in knee joint disorders.[9] This study aims to identify and establish new sign complexes in plain radiography that could indicate soft tissue abnormality that are established on MRI.[10]

METHODOLOGY

The present cross sectional study included 50 outpatients visiting our medical institute with knee pain and subjected to investigations of plain radiography and MRI were included in the study. The study was approved by the institutional ethical committee. The study included patients belonging to all ages and both sexes. Patients with bony ankylosis, fibrous ankylosis, frank fractures of the bones of knee joint and bone tumors of the knee were excluded..

Plain radiograph of the knee joint is performed using a 500mA Siemens machine using a 24 x 30cm computer radiography cassette with 56kV and 10mAs. Antero-posterior (A-P) view in standing position is taken for both the knee joints. Subsequently, A-P supine and trans-lateral views are taken for the affected knee joint.

MRI knee was done using a MAGNETOM Essenza 1.5 Tesla MRI Scanner from SIEMENS at AatmaJyoti MRI Centre, New Civil Hospital, Surat. Proton density weighted sequence in saggital plane (PDW-sag), PDW-m spin gradient inversion recovery in saggital plane (SPIR-sag), short T1 inversion recovery in coronal plane (STIR-coronal), T2-coronal, T1-coronal, T1-axial, STIR-axial, STIR-axial sequences with thin sections were obtained.

Statistical Analysis: The data is analyzed by proportions and chi square test.

RESULTS

The present study consisted of 38 males and 12 female patients. It was observed that the maximum number of patients (23 cases) belonged to the age group of 21-30 years followed by the age group of 31-40 which consisted of 11 cases. Out of 50 cases, 39 (78% of 50) of them had abnormal ACL on MRI whereas 35 (90% of 39) revealed signs of ACL injury on plain radiographs.

Table 1: Age and sex wise distribution of cases.

Age Group (Years)	Male	Female	Total (%)
1 – 10	1	0	1 (2.0)
11 – 20	4	2	6 (12.0)
21 – 30	15	8	23 (46.0)
31 – 40	7	4	11 (22.0)
41 – 50	4	2	6 (12.0)
51 – 60	2	0	2 (4.0)
61 – 70	1	0	1 (2.0)

Twelve (24% of 50) cases had abnormal contour without discontinuity of the ligament fibres on MRI, out of which 9 were identified on plain radiograph, accounting for 75% of that identified on MRI. It was observed that 20 (40% of 50) cases had discontinuity of ACL fibres on MRI, out of which 17 (85% of 20) cases revealed the features on plain radiographs. Of the 50 cases, 8 (16%) of them had discontinuity of ACL fibres with buckling of posterior cruciate ligament (PCL) on MRI and all these cases were also identified on plain radiographs indicating a statistically significant correlation.

Eight patients who presented with only PCL buckling on MRI, only 2 of them (25%) were identified on plain radiograph which was not statistically significant. Medial meniscus (MM) injury was detected in 35 (70% of 50) cases on MRI of which, 26(74% of 35 cases) had evidence detectable on plain radiographs.

Injury to lateral meniscus (LM) was evident in 18 (36% of 50) patients on MRI whereas plain radiographic signs indicating injury to LM are identified in 10 (56% of 18) cases which was statistically significant. FIve (10%) cases revealed tear in both the anterior and posterior horns of varying grades on MRI and all (100%) of them are identified on the plain radiographs.

Out of 50 cases 4 (8%) cases revealed injury to the medical collateral ligament (MCL) on MRI of which all 4(100% of those identified on MRI) cases had signs indicating the same on plain radiographs. On MRI 10 (20% of 50) cases revealed injury to the lateral collateral ligament of which 9 (90% of 10) cases were detected on plain radiographs which was statistically significant.

Among 50 patients in the study, 28 (56%) cases revealed reduction in the joint space on MRI, whereas 20 (71% of 28) cases showed reduced joint space on plain radiographs which was statistically significant. Reduction in the tibio femoral joint space medially was noted in 20(40% of 50) patients on MRI, whereas 18(36% of 50) cases showed the same on plain radiographs.

Knee joint effusion was noted in 41(82%) cases of 50 patients on MRI, of which 35 (86% of 41) cases were also detected on plain radiographs which was statistically significant. Moderate and massive joint effusion was noted in 12 and 2 patients respectively, was also detected on plain radiographs.

Six (12%) cases out of 50 revealed changes in the femur on MRI. Of the above mentioned 6 cases, 4 revealed medial condyle marrow edema on MRI, of which none of them revealed the signs on plain radiograph indicating the same. Similarly, 2 cases having geodes in the lateral condyle on MRI were inconspicuous on plain radiographs. Among the 50 cases, 18 (36%) had changes in tibia on MRI whereas 13 (72% of 18) cases showed changes in tibia on plain radiographs.

The osteophytes in the medial and lateral condyle of the femur and tibia were identified on both MRI and plain radiography and had a strong statistical significance. Similarly three(6%) cases showed fracture lateral tibial condyle on MRI which was identified on plain radiograph. In 2 (4% of 50) cases bone marrow edema/contusion, was identified on MRI whereas none of them were identified on plain radiographs. The changes in joint space were clearly depicted in 16 cases (32%) in the plain radiography which were less obvious on MRI due to the supine positioning of the patient during the procedure.

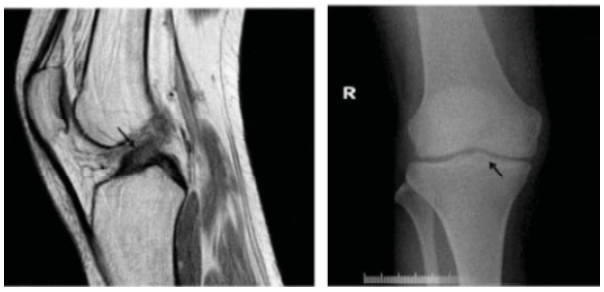

Fig. 1(a) MRI of a 24 year old male patient showing ACL strain revealing the abnormal contour of the ACL (arrow) and the corresponding AP view of plain radiograph is shown in Fig. 1(b) AP view of plain radiograph of a 24 year old male patient showing prominence of medial intercondylar eminence (arrow).

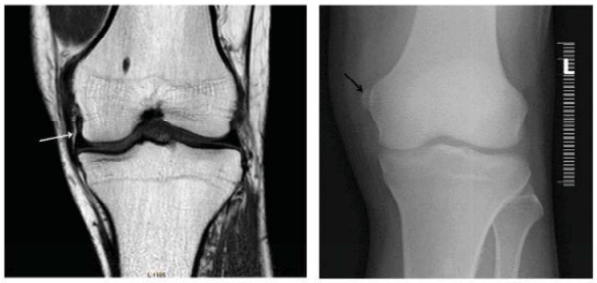

Fig. 3(a) MRI of 26 year old male patient showingmedial collateral ligament injury (arrow), whereas the corresponding plain radiograph (b) showing calcification at the attachment of MCL to the medial femoral condyle (Pellagrini steida syndrome) Fig. 3(b) The plain radiograph of 26 year old male patient showing calcification at the attachment of MCL to the medial femoral condyle

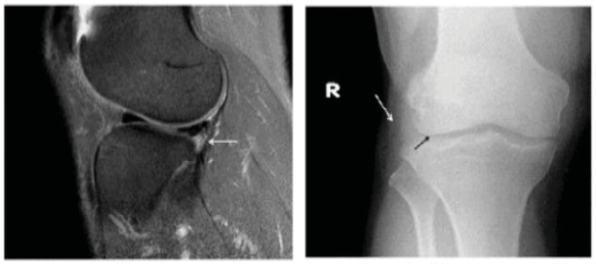

Fig. 2(a) MRI of 26 year old male patient showing grade III tear of lateral meniscus posterior horn (arrow) Fig. 2(b) The plain radiograph of 26 year old male patient showing grade III tear of lateral meniscus posterior horn on the MRI (Fig. 4(a)) shows decreased lateral tibio femoral joint space (black arrow), with indistinct lateral fat planes (white arrow)

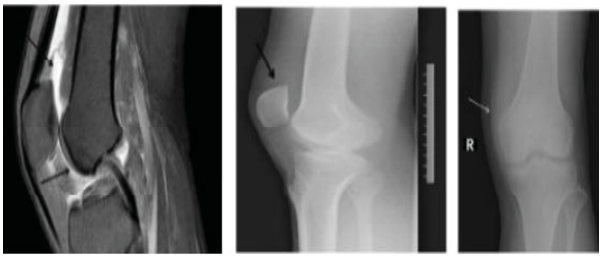

Fig. 4(a) MRI showing knee joint effusion in a 48 year old female patient which appears as hyperintense areas (arrows) on T2 image (b) plain radiograph showing fullness/ increased density in the supra patellar region on lateral projection (arrow) and (c) lateral displacement of the soft tissues at the tibio femoral joint on AP view of a 40 year old female patient (area of increased density shown by an arrow)

DISCUSSION

Radiography is the first step in the evaluation of the knee joint disorders. It can readily reveal fractures, osteochondral defects, bony lesions, joint effusions, joint space narrowing and bone mal-alignment. The knee is the largest, complex, bicondylar, synovialjoint in the body.[3] The soft tissues around the knee comprise: fibrous capsule, menisci, cruciate ligaments, collateral ligaments and medial and lateral stabilizing structures of the knee. The injuries involving these structures along with bone and bone marrow are well identified on the MRI. In order to evaluate internal derangement adequately, the axial, coronal and sagittal planes using thin sections (3mm thick) with a combination of T1- and T2- weighted sequences, short tau inversion recovery (STIR) or T2 –weighted image with fat suppression are required.[4] Tears in the structures or discontinuity in the fibres, edema/contusion or effusion in the joint space, sclerosis, geodes, cysts, osteophytes and fracture can all be appreciated on MRI. Similarly on the plain radiographs, the displacement of synovial fluid, spiking of the intercondylar eminence, displaced soft tissue planes, indistinct fat planes, enlargement of joint space, compression fractures can be appreciated.

The sagittal plane is most important plane in assessing the menisci, with a coronal plane providing supportive rather than new information and the axial plane increasing the accuracy of the sagittal and coronal planes when combined.[5-7] The medial and lateral menisci, the transverse ligament, and the menisco femoral ligament appear homogenously dark on all pulse sequences. The vascular and avascular zones cannot be distinguished on MRI.[8]

In primary healthcare setups where MRI facility is not available, the plain radiography becomes the key in analyzing the changes in the soft tissues along with the well-established changes in the hard bony tissues. MRI is an expensive, not readily available investigation at the level of primary health care centres. However MRI is a noninvasive gold standard investigation in establishing soft tissue injuries of the knee joint.

The objective of our study was to establish new signs on plain radiography of the knee joint that would indicate soft tissue injury, thereby obviating the need

for expensive, not readily available investigations like MRI at a primary level. On reviewing the literature it was found that our study is first of its kind (unique) in establishing signs on plain radiography that indicate soft tissue injury of the knee joint.

Plain radiographs are 91% sensitive and 86% specific for osteoarthritis when combined with criteria indicating osteoarthritis, including any of the following: age more than 50 years, crepitus and morning stiffness of 30 minutes or less.[9]

Lateral condylar depression and widening, as measured on plain radiographs was helpful in identifying the soft tissue injury and planning open or arthoscopic treatment methods in centres with limited availability of MRI.[10] Localized development of knee osteoarthritis can be predicted from MR imaging a decade earlier.[11] Study to correlate the clinical assessment, radiographic and MRI findings revealed that MRI was far superior to plain radiography and better than clinical assessment and has a high sensitivity, accuracy and positive predictive value.[12]

The six sign complexes that where observed on plain radiography would be of great value in diagnosing soft tissue pathologies where the MRI facility is not available. They are:

1. **ACL:** Signs on plain radiogram that indicate ACL injury are spiking of intercondylar eminence, with either sclerotic margin or irregular margin with or without underlying osteopenia, fracture of intercondylar eminence indicates ACL injury.

2. **Medial meniscus injury/tear:** Signs on plain radiogram that indicate medial meniscus injury/tear are reduced tibio-femoral joint space medially, sclerosis of medial tibial plateau, with laterally displaced soft tissue planes.

3. **Lateral meniscus:** Signs on plain radiogram that indicate lateral meniscus injury/tear are sclerosis of lateral tibial plateau, lateral tibial condyle, fracture, laterally displaced soft tissues at the tibio-femoral joint and decrease in lateral tibio-femoral joint space.

4. **Medial collateral ligament:** Signs on plain radiogram that indicate injury to medial collateral ligament are displacement of medial soft tissue planes at medial tibio-femoral joint, calcification at medial femoral condyle at the site of attachment of medial collateral ligament.

5. **Lateral collateral ligament:** Signs on plain radiogram that indicate injury to lateral collateral ligament are indistinct lateral fat planes at the tibio-femoral joint, laterally displaced lateral soft tissue planes.

6. Signs on plain radiogram that indicate joint effusion are increased density in the suprapatellar and infrapatellar regions on lateral x rays. Also laterally displaced fat planes with increased density on AP films.

CONCLUSION

Knee joint pain is a common complaint patients present with, especially in middle and old ages. The causes can be various being bony or soft tissue injuries. Radiology plays a major role in diagnosing the cause of pain and thereby in its management. The present study was done to identify signs on plain radiography that indicate soft tissue injuries of the knee joint that are otherwise established on MRI and thus correlate signs on plain radiographs with that of MRI. Specific observations regarding the knee joint space, tibial inter condylar eminence, the bone density, soft tissue planes at the tibio femoral joint medially and laterally, density at the suprapatellar and infra patellar region, compression fractures of the tibial plateaus / femoral condyles/ inter condylar eminence reveal invaluable signs revealing injury to the menisci, cruciate ligaments, collateral ligaments, knee joint effusion when carefully assessed and interpreted on the plain radiographs. Thus though MRI today is the standard modality to diagnose soft tissue injuries of the knee joint, plain radiography a readily and universally available investigation at all levels of health care systems certainly does reveal certain signs that indicate injury to the soft tissues of the knee.

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