INTRODUCTION

MRI is the imaging modality of choice to detect internal knee derangement.\(^1\)\(^2\) It is performed for a number of indications including meniscal and ligament abnormalities, osseous and osteochondral abnormalities, neoplasm, infections, and congenital abnormalities.\(^3\) When comparing MRI and diagnostic arthroscopy for anterior cruciate ligament and meniscal tears, MRI is superior and offers the health benefit of avoiding invasive surgery.\(^4\) MRI not only aids in diagnosis but also helps regarding treatment planning and prognostication. It is an effective tool to select patients for targeted therapeutic arthroscopy.\(^5\) However, this is only possible if it is properly performed and interpreted.

Key image quality parameters include full anatomical coverage, appropriate image orientation, sufficient signal-to-noise ratio, spatial resolution, spatial and signal homogeneity, and absence of technical artifacts.\(^6\) The spatial resolution and SNR (signal to noise ratio) are inversely related and depend on factors like slice thickness and FOV (field of view). Not only the judicious and appropriate selection of these parameters is important when setting up a particular MRI sequence, but it is important that key anatomical structures are included in the imaged area so as not to miss any pathology.

The purpose of this audit was to evaluate the quality of imaging in MRI of knee joint, performed in Radiology Department of Jinnah Hospital, Lahore.

METHODOLOGY

The first audit was performed in Radiology Department of Jinnah Hospital, Lahore in August 2015. The data was collected retrospectively from MRIs of knee, performed during the month of August. Twenty-one knee MRIs were performed for various indications during this month; out of which, 20 were included in the audit. One study was excluded because the patient was uncooperative and hence the imaging was abandoned during scan and was incomplete. The studies were assessed for various parameters including both anatomical coverage and technical parameters (FOV, slice thickness and interslice gap) and the data collected in a specially designed performa. Percentages were then calculated. The standard was set as 100 % compliance to ACR guidelines.\(^3\)

These guidelines included technical parameters and anatomical coverage. Technical parameters included imaging acquired in sagittal, coronal and axial planes, FOV of 16 cm or smaller, slice thickness of 4 mm in...
coronal and sagittal planes, and interslice gap of 33-50% of slice thickness. Anatomical coverage extended superiorly to include distal aspect of quadriceps tendon and suprapatellar joint recess and inferiorly to include insertion of patellar tendon and pes anserinus.

Based on the results of the first audit, recommendations were made and conveyed to the whole Radiology Department through meetings. The ACR guidelines for MRI knee and other commonly performed MRIs were printed out and displayed prominently in the console room and handouts were given to the technicians as well as residents.

These recommendations included the need for MRI technicians to be updated regarding the current guidelines for performing MRI scans through regular workshops / training sessions, the guidelines for the most commonly performed MRIs to be displayed prominently in the console room for easy reference and first and second year residents to monitor the scans during performance and guide the technicians.

A re-audit was planned after 6 months to check the implementation of these recommendations. Subsequently, a re-audit was done in the same department, 6 months later in February 2016. Data of 16 patients, who had undergone MRI knee in the month, was analyzed for anatomical coverage and technical parameters (FOV, slice thickness and interslice gap). The technicians and residents were blinded to the audit and were not told beforehand that the re audit would be performed in that month. The data was collected in the same performa. It was entered in SPSS version 20, and frequencies and percentages were then calculated.

RESULTS

As summarized in Table I, images were acquired in all the three, i.e. axial, coronal and sagittal planes in 20 cases. However, the FOV was not set according to the recommendations in most of these cases; FOV was 16 cm or less in axial images in only 13 of the 20 studies (66%), and in only 1 case in sagittal plane (5%). In the images acquired in coronal plane, an FOV of greater than 16 cm was used in all the cases.

The slice thickness had been appropriately set. Hundred percent of the cases studied had been performed using slice thickness of 4 mm or less in both coronal and sagittal planes. Similarly, the interslice gap was also according to the guidelines in all 20 cases.

The anatomical coverage was adequate both superiorly as well as inferiorly in both sagittal and coronal planes as advised in the ACR guidelines in all the 20 studies. However, this was not the case with axial imaging where superior coverage was according to guidelines in only 13 (66%) cases and the inferior coverage was adequate in 16 cases (80%).

However, the re-audit done 6 months later showed achievement of target compliance with standards of 100% as summarized in Table I. The anatomical coverage was adequate both superiorly as well as inferiorly in both sagittal and coronal planes as advised in the ACR guidelines in all the 20 studies.
coverage in all 3 planes as well as all the technical parameters including FOV, slice thickness and interslice gap was according to the standards set showing 100% compliance.

DISCUSSION

MRI is the most commonly used imaging modality for evaluation of knee joint. Since the first use of MRI in 1983 for assessment of knee, the most significant advances in knee imaging have been made in the realm of MR imaging. Infact, it is now the non-invasive imaging modality of choice for supplementing the physical examination in the evaluation of both intra-articular and extra-articular injuries of the knee. This is not surprising considering that it is an excellent tool for evaluation of bony, cartilaginous, ligamentous and synovial pathologies of knee joint ranging from trauma to infection and neoplasm.

However, image analysis, regardless of the sophistication and talent of the readers or the power of the image-processing and analysis software used, can only be as good as the quality of the original images acquired. Therefore, proper image acquisition is imperative for proper diagnosis and evaluation.

MR image quality depends on a number of parameters including magnetic field strength, the pulse sequence and timing, number of excitations, slice thickness, slice separation, dimensions of the image matrix and FOV, inherent or injected contrast, and the use of surface coils. In addition, it is essential that all the structures are included in the imaged area so as not to miss any pathology.

When imaging knee joint, it is helpful to acquire images in sagittal, coronal and axial planes to define and characterize abnormalities, because the structures forming this complex joint are so oriented that they cannot be evaluated properly in a single plane. While sagittal view is the basis for knee MRI including anterior cruciate ligament evaluation, menisci and collateral ligaments are best evaluated in coronal view whereas, axial images are best for evaluation of periarticular fluid collection, plicae, patellofemoral joint, and femoral attachments of cruciate ligaments.

Imaging had been performed in all three planes in all the patients who had underwent MRI knee in our department. Spatial resolution is one of the key factors that determine the quality of an image as it affects the ability to discern fine details. This, in case of MRI, depends on FOV. While using a larger FOV, enables coverage of a larger area and improvement in SNR, which compromises the spatial resolution. In order to avoid chances of missing a subtle pathology due to poor spatial resolution, it is desirable that the FOV in case of MRI of knee be kept 16 cm or less. This was one parameter that had been overlooked in most of the cases in all the three planes particularly sagittal and coronal planes.

Slice thickness affects the image sharpness and signal strength. By virtue of its effect on spatial resolution and partial volume effect, it affects image quality. However, as with other factors, a compromise has to be achieved between resolution and SNR. Since there be subtle pathologies involving the ligaments, a slice thickness of 4 mm is desirable to detect these. This was achieved in 20 cases.

Interslice gap is the gap between two contiguous MRI slices; and is necessary in order to avoid ‘cross-talk’. However, detection of high-contrast lesions is shown to be limited primarily by the presence of a gap between slices. Therefore, when selecting an appropriate interslice gap a compromise has to be struck between optimal SNR which requires a large enough gap to eliminate cross-talk and the desire to reduce the amount of information missed in this gap. ACR recommendation of this to be less than 33-50% of the slice thickness was followed in 100% of the cases studied.

Apart from these technical parameters, it is necessary that all the structures related to knee joint are imaged; obviously, if an abnormality is not included in the imaged area it cannot be detected. Superiorly, distal aspect of quadriceps tendon and suprapatellar joint recess must be imaged. Quadriceps tendon degeneration is one of the indications for MRI of knee. Suprapatellar joint recess can be involved by a number of congenital, traumatic, inflammatory and neoplastic conditions. These may be missed, if these areas are not imaged. These were imaged, in coronal and sagittal planes in the 20 cases, but missed in seven of the cases in the MRIs performed in our department.

Pes anserinus and patellar tendon can also be involved in pathologies and, therefore, the inferior coverage in MRI knee should be extended to include them. While this was adequately done in all the patients in coronal and sagittal slices, axial slices were not obtained upto the standard set.

The second audit, done 6 months later, showed full compliance with the standards set. The basic step taken during this period was to guide the technicians regarding the proper protocol for setting parameters when performing MRI of the knee and secondly to involve the residents right from the early years of their training in the technical aspects of the imaging so that they are aware of these important aspects which can have implications for interpretation, and subsequently diagnosis of pathologies.

CONCLUSION

MRI is the most commonly used imaging modality for assessing knee abnormalities. However, proper image acquisition is necessary for good image analysis and
imperative for thorough evaluation of pathology. This requires usage of proper technical parameters and adequate anatomical coverage. It is important to guide the technicians regarding these and to involve the residents in these technical aspects of radiological investigations.

REFERENCES