PICTORIAL REVIEW

IMAGING ROAD MAP TO ASSESS GLENOID LABRUM ON MRI

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ABSTRACT

PURPOSE OR LEARNING OBJECTIVES: To describe ideal imaging technique and sequences for MRI shoulder.To describe roadmap for assessment of glenoid labrum and labral pathologies.To explain associated findings with labral injury. **BACKGROUND:** MRI is the modality of choice to assess internal derangements in shoulder joint. Labrum is attached to the glenoid margin and gives depth to the glenoid cavity. Labral injuries are common following trauma to shoulder joint. A roadmap should be in place to stepwise assess the labrum, its normal characteristics, its variations and tears. In this educational poster, we aim to emphasize ideal steps in reaching the final diagnosis of labral pathology without need of MR Arthrogram. **FINDINGS:** MRI Shoulder is ideally performed in three planes. The coronal and sagittal planes are obtained obliquely due to joint's oblique orientation. Ideal sequences are PD and PD FATSAT in all three planes. Labral injury is associated with periosteal stripping, chondral injury, bone injury, torn glenohumeral ligament or even ruptured capsule. **CONCLUSION:** MRI is essential in diagnosing labral injuries and knowledge of approach to MRI can help reach final diagnosis without arthrogram.
Keywords: Musculoskeletal joint, MR, Diagnostic procedure, Trauma

Learning Objectives

To Describe ideal technique for MRI shoulder.
To Describe MR imaging roadmap for assessment of glenoid labrum.
To Explain associated findings with labral injury.

Introduction

MRI is the modality of choice for diagnosing musculoskeletal internal derangements. Shoulder joint pain is a common presentation, even many years after trauma. MRI has the ability to diagnose minute details of cartilage, tendons and labrum. Glenohumeral articulation is a shallow ball and socket joint. Labrum is attached to the glenoid margin to give it depth. Glenoid Labrum is one of the overlooked structures while reporting MRI shoulder.[1] The cause can be limitation of improper planes or inadequate sequence for labrum assessment or sometimes in chronic labral injury, the lesion is not clearly identifiable without an arthrogram. While reporting MRI Shoulder, a roadmap is essential to stepwise assess labrum. For this the first step is proper imaging.

MR Technique:

Planning: To understand the labral anatomy and pathologies on MRI ideal imaging is required. It is not possible without proper planning. Shoulder joint needs more careful planning for assessment of minute details due to its oblique orientation (Fig.1). Coronal Plane should be planned on axial localizer in such a way that each slice is parallel to long axis of supraspinatus muscle. Sagittal plane should be acquired from planning on axial localizer in such a way that its

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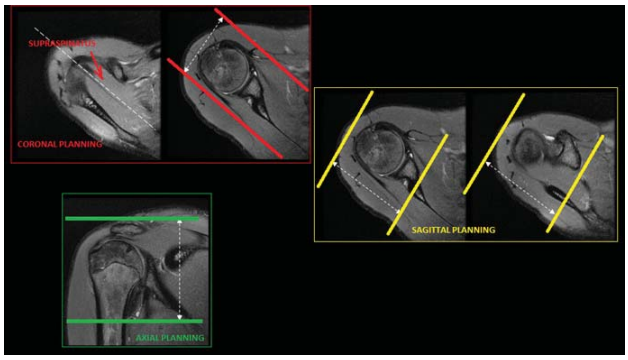

Figure 1: MRI Shoulder planning. Note the coronal images are planned parallel to long axis of supraspinatus muscle belly and sagittal images are planned perpendicular to long axis of supraspinatus

each slice is perpendicular to the long axis of supraspinatus muscle.[2] Axial plane is achieved taking perpendicular slices from long axis of humerus, however for acquiring axial plane images, it is essential to start from above the level of acromioclavicular joint (AC Joint).

MRI Sequences: Musculoskeletal MRI is being done with varying protocols, depending mostly on radiologists' experience. Individual preference of sequences plays a role in approaching shoulder MRI, however a routine imaging acquisition typically includes sequences acquired in axial, oblique sagittal and oblique coronal planes. Routinely at multiple centers,

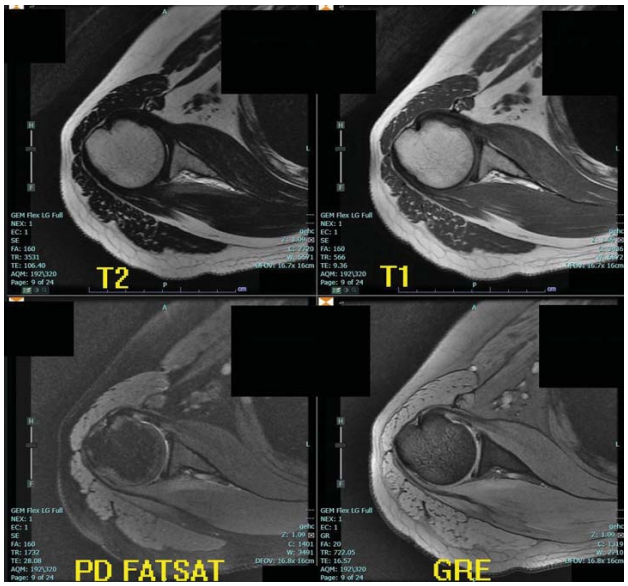

Figure 2: Multisequential comparison. Note the soft tissue contrast ad intrinsic details are better visualized on PD FATSAT image as compared to T1, T2 and GRE. Also note the small tear in infraspinatus better visualized on PD image.

T1-weighted (T1), Proton Density weighted (PD) and fluidsensitive parameters are used.

(Fig.2) shows the comparison of T2WI, T1, PD and GRE images. At our institution, MRI of the shoulder is performed on 1.5-T MRI scanner. Our routine imaging planes and sequences for non-arthrographic studies include coronal oblique, sagittal oblique and axial planes of turbo spin-echo PD and fat-suppressed PD sequences alongwith sagittal oblique T1. PD is imaging sequence having long TR and a short TE with the ability to characterize pathologies in ligaments, labrum, cartilage and cortex, whereas the abnormal fluid and edema is identified on PD FATSAT (Fig.3). Routinely, no intravenous contrast is given for shoulder MRI and an MR Arthogram is reserved for selected cases, where it is not possible to decide GHL injury on a routine MRI or on referring surgeon's choice.

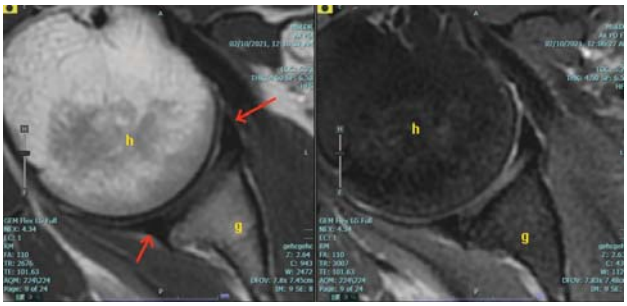

Figure 3: Axial PD and PD FATSAT images of shoulder joint at level of mid glenohumeral articulation showing good contrast between normal labrum, cartilage and cortex. Normal Labrum (arrows). g=glenoid. h=humerus.

Findings

MRI can depict labral injuries and has been traditionally used to differentiate labral tears from other causes of shoulder pain.[3,4] The appropriate treatment following a labral injury requires differentiation between a simple labral tear and labral tear associated with other regional injuries. To assess labral injury on MRI, the ideal roadmap should include stepwise assessment of labrum on axial and coronal planes with help of sagittal plane in suspected superior labral injury.

Importance of each plane in stepwise assesment of labrum:

Each imaging plane has its benefit in assesment of

certain anatomic structure. We would remain focussed on labral assesment in this review. The axial plane is most useful for evaluation of both the anterior and posterior glenoid labrum whereas the coronal plane is helpful for assessing the biceps-labral anchorage/ anchor complex (Fig.4).

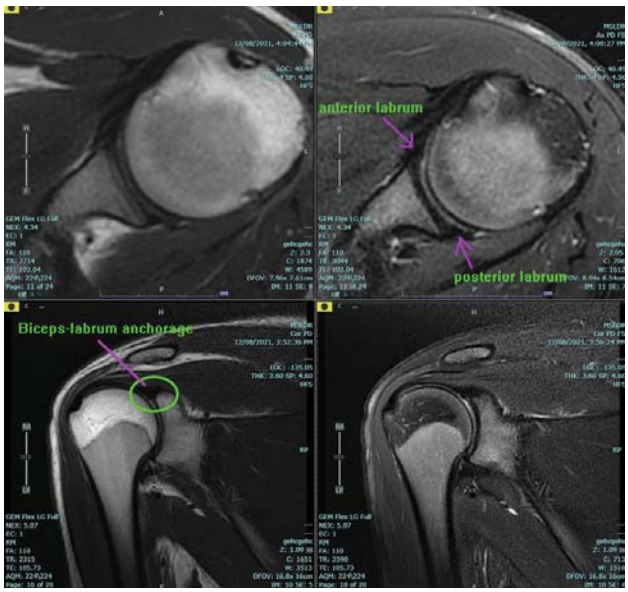

Figure 4: Axial and coronal PD and PD FATAST images of a patient with normal labrum. Anterior and posterior labrum is assessed on axial images. Coronal images are useful for assessment of Biceps-labrum anchorage.

Although the sagittal plane when ideally acquired through the labrum can locate the labral injury (face of clock), however in routine imaging, it is very rare to acquire a slice through the labrum. The usage of sagittal plane in labral assesment is as a reference point for biceps anchorage, especially in superior labral tears, where we have to differentiate between a tear and normal variant (e.g. labral foramen). Let s move forward towards assessment of glenoid labrum. The first step is to identify normal labrum.

1. Normal Glenoid Labrum:

On axial and coronal MRI, a normal labrum has the following characteristics (Fig.5):

Triangle shaped or rounded. Poster labrum is often smaller.

Hypointense or Black on all sequences.

There should not be any high signal undercutting it or no signal seen at the base of labrum. It is important to mention here that the abnormal high signal intensity mentioned here should be isointense to a fluid signal on both PD and PD FATSAT sequences.

The normal Biceps- labrum-cartilage complex is seen on coronal plane.

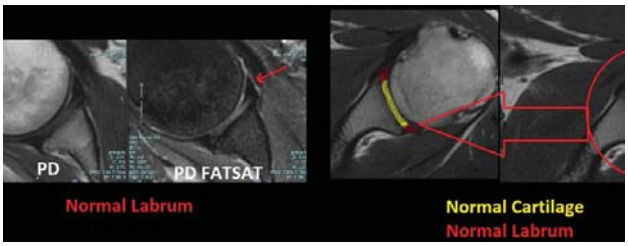

Figure 5: Normal Labrum should be hypointense on all sequences (small arrow). Normal cartilage should be intermediate signal intensity and is best visualized on PD image located between the anterior and posterior labrum with smooth surface, smooth thickness and homogenous signals on PD images (yellow colored area).

If there are high signals at the base of labrum, the next step is to locate it. In cases, where the abnormal signal is seen in superior labrum, the next step is to differentiate it from normal labral variant.

2. Labral normal variants:

To understand location of normal labral varaints, labrum is divided into imaginary five compartments on sagittal plane. This has been beautifully illustrated by RadEdAsia by correlating glenoid shape to a pear (Fig.6). Anatomical labral variants occur in the Superior and Anterior Superior Quadrants. Important here is to remember that Biceps insertion (Superior quadrant) is an important landmark in differentiating normal labral variants from superior labral anterior posterior tears (SLAP tears). Normal variants do not extend

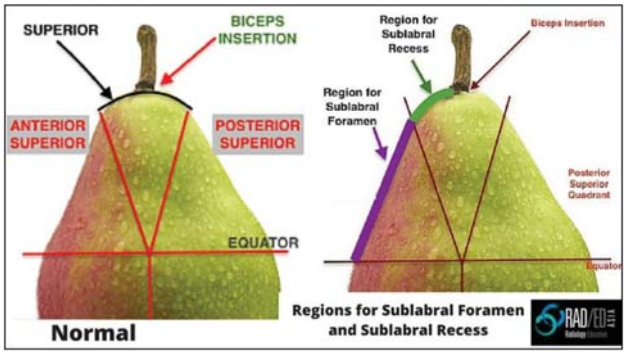

Figure 6: To understand location of normal labral varaints, labrum is divided into imaginary five compartments on sagittal plane. This has been beautifully illustrated by RadEdAsia by correlating glenoid shape to a pear.

posterior to the biceps insertion or inferior to the equator. The equator is considered the lower margin of tip of coracoid. The normal labral variants include the sublabral recess, labral foramen, Buford Complex etc.

Now that we have ruled out presence of labral variant and the signal seen in labrum is not following the compartmental location of a variant, it is considered a tear.

3. Labral Tear:

Standard appearance is to look for a high signal cleft at the base of the labrum on fluid sensitive sequence, preferably PD. Any hyperintense fluid signal seen at the base of the labrum is considered a tear (Fig.7). It is seen cutting the base of the labrum. It can be a partial or a full thickness tear. Mostly a full thickness labral tear is seen.

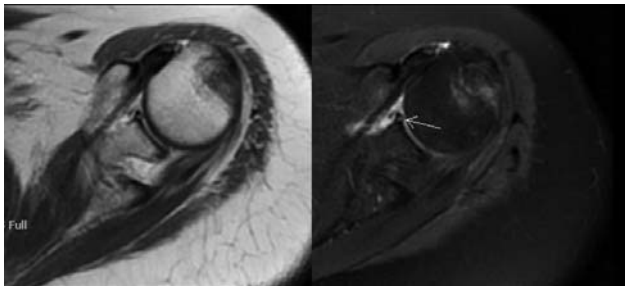

Figure7: Labral Tear. High signal cleft seen at the base of anterior labrum on both PD and PD FATSAT images. Also note abnormal marrow signals in humerus head (Hill Sachs).

The glenoid labral tear needs to be further characterized with identification of associated findings as follows:

1. Extent of Tear.
2. Cartilage Injury.
3. Periosteal Injury.
4. Bone Injury (Bankart and Hill Sachs).
5. Glenohumeral Ligament Injury.
6. Chronicity of Tear and Paralabral cysts.

Extent of Tear:

Labral tear should be identified as anterior or posterior labral and then whether it is in the superior or inferior labrum. In certain cases, the labral tear is seen circumferentially involving the labrum. It is important to locate the torn detached labral fragment (Fig.8) and also to differentiate it from certain mimickers like thickened MGHL in cases of Buford or loose bodies from ostochondral injuries. (Fig.9)

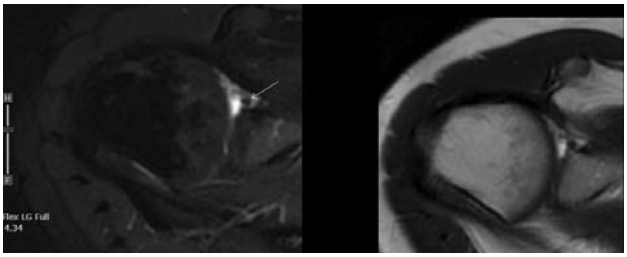

Figure 8: Axial PD FATAST and PD images of Glenohumeral articulation. Labral Tear with detached labral fragment seen along anterior glenoid (arrow). Also note abnormal cortical depression in posterior aspect of humerus head (Old Hill Sachs).

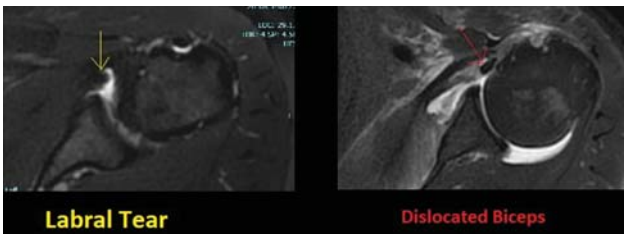

Figure 9: Labral Tear (yellow arrow). It is important to locate the torn detached labral fragment and also to differentiate it from certain mimickers like displaced long head of biceps tendon (red arrow). Note the empty biceps groove.

Cartilage Injury:

Articular glenoid cartilage can be damaged in shoulder dislocation alongwith a labral tear. Normal cartilage has intermediate grey signal on all sequences. It is of uniform thickness located between the anterior

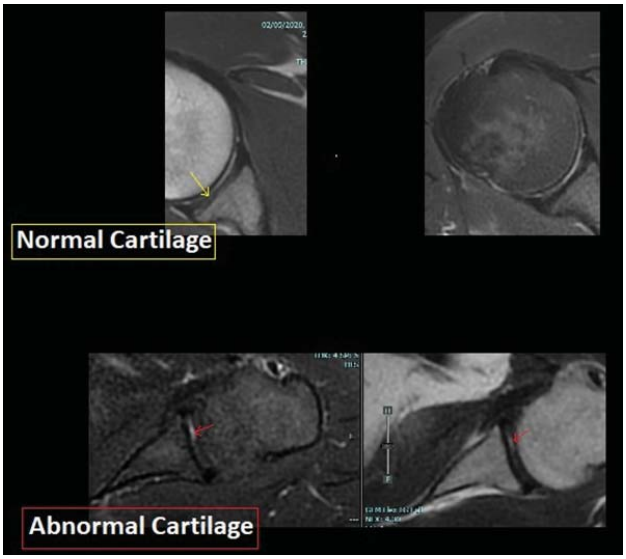

Figure 10: For abnormal cartilage, look for areas of higher signal than the intermediate grey of normal cartilage on PD and PD FATSAT images (red arrows).

and posterior labrum (Fig.5). For abnormal cartilage, look for areas of higher signal than the intermediate grey of normal cartilage on PD (Fig.10)

Periosteal Injury:

Normal periosteum is not seen separate to bone cortex on MRI. In cases with labral injury, it is important to look for periosteal damage, the expected site of which is the junction of labrum and outer bone cortex as this is the site where periosteum is first stripped from during a labral tear (Fig.11).

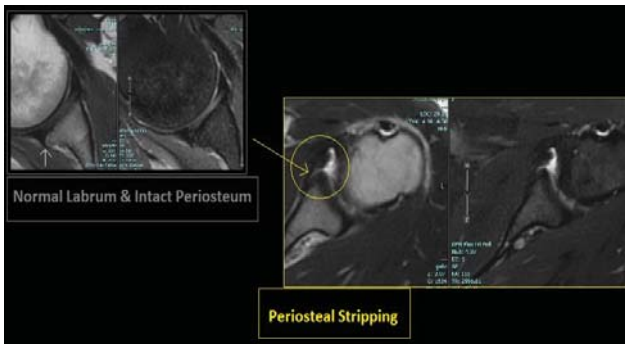

Figure11: Axial PD and PD FATSAT images showing comparison of periosteal stripping (yellow arrow) and intact periosteum. White Arrow points to the expected site where periosteum is first stripped from during a labral tear.

There are certain terms used for periosteal damage: Periosteal stripping is term used when a grey signal intensity stripped structure (stripped elevated periosteum) is seen along the torn labrum at its outer aspect with or without loss of normal signal void rim of adjacent cortex (Fig.12).

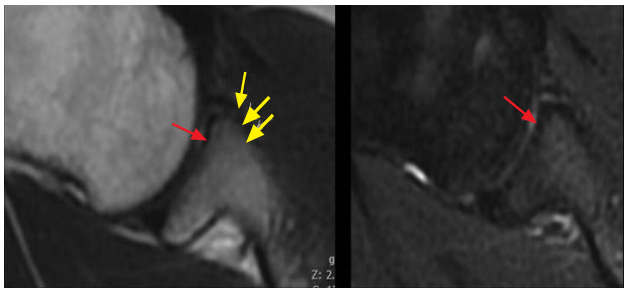

Figure 12: Axial PD and PD FATAST images showing anterior labral tear with associated periosteal stripping (yellow arrows) and cartilage injury (red arrow).

Retraction of periosteal stripping is seen when the stripped periosteum is displaced and retracted. In some cases the torn labrum is displaced and lodges deep to the stripped periosteum (Fig.13).

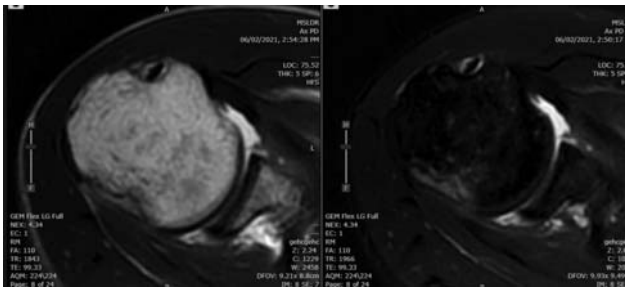

Figure 13: Axial PD and PD FATSAT images show torn anterior labrum with periosteal stripping and retraction. Note the bone marrow abnormality in posterior humerus head, in keeping with Hill Sachs.

Bone Injury:

(Bankart and Hill Sachs) In shoulder dislocation, the anteroinferior labral injury, also called as Bankart lesion can be associated with injured glenoid bone called the bony Bankart (Fig.14).

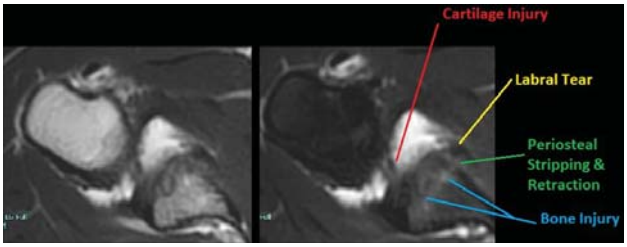

Figure 14: Labral Tear with associated bone injury seen as marrow edema on PD FATSAT image. Also note the stripped retracted periosteum and cartilage avulsed injury.

There is also associated osseous injury at the posterior superior humerus head. It is evident as acute marrow edema with cortical disruption in acute injury or a cortical depression in old injury (Fig.8). On axial images, the humerus head injury should be visualized as depression in slices above the level of coracoid to differentiate it from a normally seen cortical dip in humerus on axial images (Fig.15).

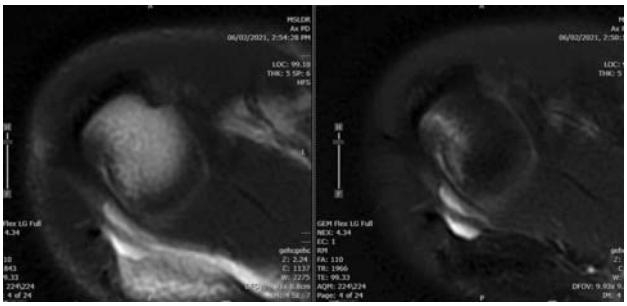

Figure 15: Axial PD and PD FATSAT images showing classical appearance of Hill Sachs lesion in posterior superior aspect of humerus head. PD FATSAT images show marrow edema due to trabecular microfractures. Posterior cortical depression is seen indicating recurrent dislocation related to impaction injury, better appreciated on PD image.

Glenohumeral Ligament Injury:

Anterior inferior labral injury is associated with injured inferior glenohumeral ligament (IGHL). IGHL has two bands, anterior and posterior. The posterior band is not separately visualized from the capsule. The anterior band of IGHL is a thick structure located at anterior inferior aspect of glenoid and has attachment to inferior glenoid labrum. Bankart lesion has associated tear of this band (Fig.16).

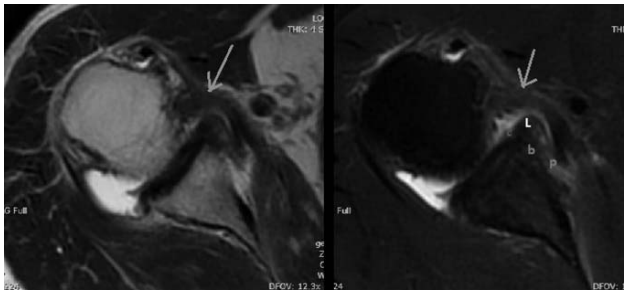

Figure 16: Axial PD and PD FATSAT images showing anterior inferior labral tear (L) with associated tear of IGHL anterior band seen as thick ill defined hyperintensity (arrow). Also note the bone injury (b), periosteal stripping (p) and cartilage injury (c).

Chronicity of Tear and Paralabral cysts:

Chronic labral tear if partial might be missed due to presence of scar tissue at the tear site and is seen as hypointense deformed labrum. Other finding associated with chronic labral tear is presence of paralabral cysts, which can be large enough to mimic a bursa. These can be a cause of nerve compression when involving supragenoid notch. These can get infected or have loose bodies etc.

Fancy terms and acronyms are present for the above findings (Fig.17). The main focus in reporting should be describing the above findings in labral injury than to fit it into one neat fancy acronym.

Reporting Tips (Fig.18 & 19):

While reporting MRI shoulder, try to start reading the scan from labrum and Axial PD is the image to start with.

Concentrate on what the abnormalities are and give a good description of them rather than just mentioning single acronym. Surgeons are more interested in description of actual findings.

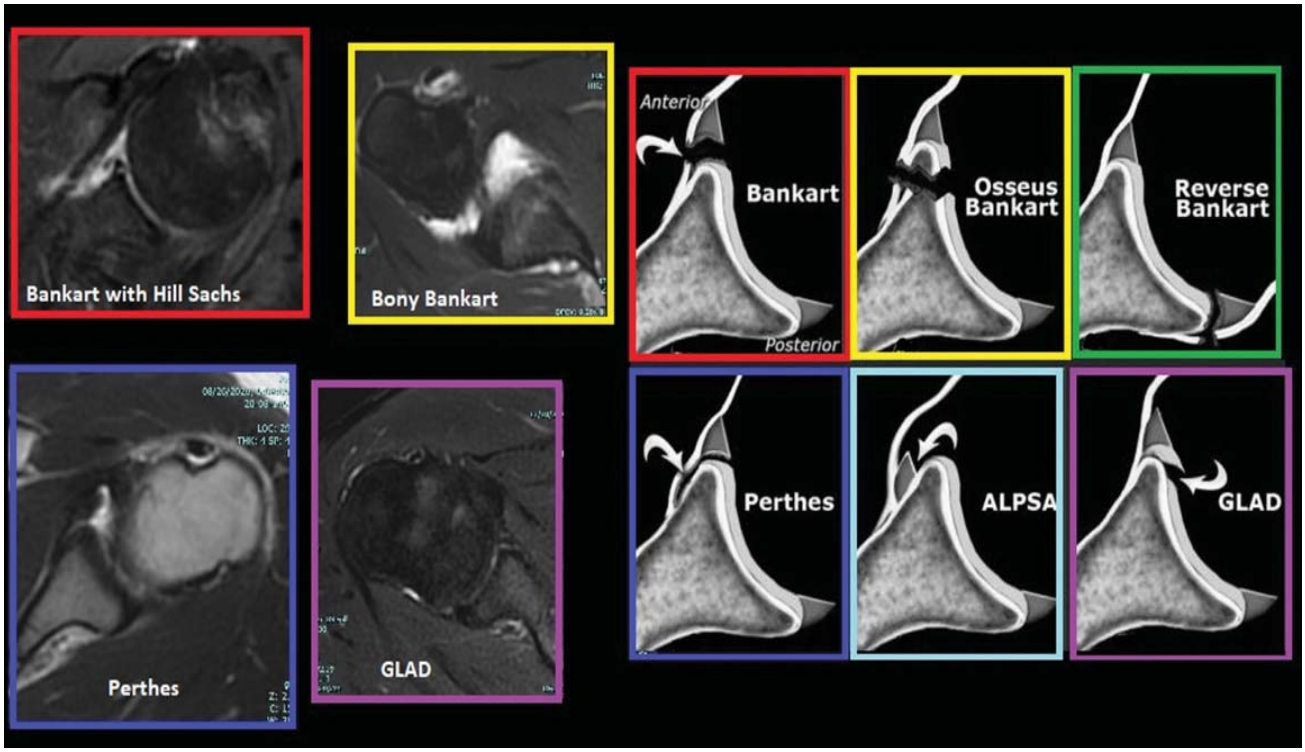

Figure 17: Labral Tear Fancy terms and acronyms. Widely known acronyms exist for labral tears and associated findings. It is important that main focus in reporting should be describing the findings in labral injury than to fit it into one neat fancy acronym e.g. writing "anterior inferior labral tear with associated periosteal stripping" would have more impact than " Bankart with Perthes". Similarly, "Perthes with GLAD" would have more impact if written as " Labral tear with associated periosteal stripping and cartilage injury".

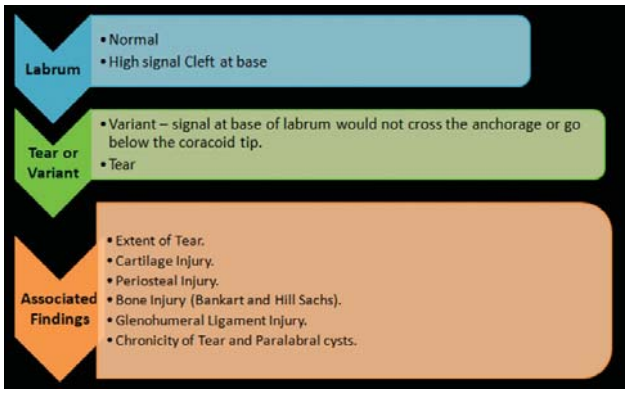

Figure 18: Chart Flow for easy assessment of Glenoid Labrum on MRI.

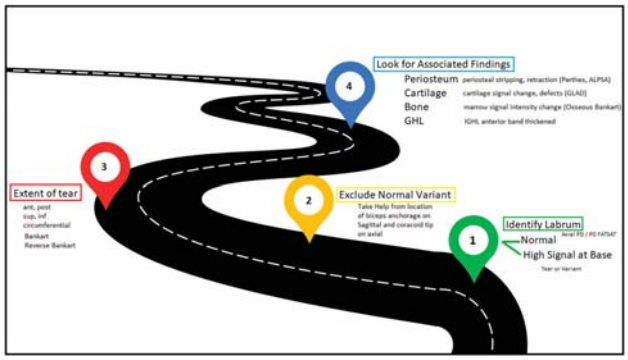

Figure 19: Road map for imaging assessment of glenoid labrum, labral tears and associated findings on MRI.

Conclusion

MRI is essential in diagnosing labral injuries and following a roadmap to assess labrum helps identifies extent of tear and its associated injuries like periosteal stripping, chondral injury, bone injury, torn glenohumeral ligament, paralabral cysts or even ruptured capsule.

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Conflicts of Interest: None

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