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REVIEW ARTICLE

IMAGING IN ANTERIOR SHOULDER DISLOCATION

OBRAZOWANIE PRZEDNIEGO ZWICHNIĘCIA BARKU

Przemyslaw Lubiatowski[1,2], Joanna Wałecka[3], Jakub Stefaniak[3]
[1]Department of Traumatology, Orthopaedics and Hand Surgery, University of Medical Sciences in Poznań, Poland
[2]Sports Traumatology and Biomechanics Unit, Rehasport Clinic, Poland
[3]Upper Limb Unit, Rehasport Clinic, Poland

ABSTRACT
Shoulder dislocation is a very common musculoskeletal injury. Imaging in such cases serves an important role in the diagnostic and therapeutic process. Despite a pretty simple clinical diagnosis, the process itself is long for the patient and associated with multiple steps and decision making to regain function with low risk of prolonged disability (Zygmunt *et al.,* 2013; Lubiatowski *et al.,* 2016). There are also many controversies as well as significant diversity among surgeons regarding the timing and choice of particular diagnostic modalities used in diagnostics of different scenarios of shoulder dislocation. The aim of imaging in shoulder dislocation is to confirm dislocation and its direction and finally successful reduction. That usually is served by conventional radiography. Additionally, imaging may be required to identify soft tissue or bone injuries or, when necessary vascular and nerve injuries using different modalities (CT, MR, US). The selective radiographic evaluation may reduce the number of X-rays, costs, and most of all time before reduction and spent by a patient in an emergency unite. That should be used carefully to avoid misdiagnosis.

Keywords: shoulder dislocation, imaging, radiography, instability, magnetic resonance.

STRESZCZENIE
Zwichnięcie barku jest bardzo częstym urazem układu mięśniowo-szkieletowego. Obrazowanie w takich przypadkach pełni ważną rolę w procesie diagnostyczno-terapeutycznym. Mimo dość prostej diagnozy klinicznej, sam proces jest dla pacjenta długi i wiąże się z wieloetapowym podejmowaniem decyzji w celu odzyskania funkcji z niskim ryzykiem przedłużonej niepełnosprawności (Zygmunt i wsp. 2013, Lubiatowski i wsp. 2016). Istnieje również wiele kontrowersji, a także duże zróżnicowanie wśród chirurgów dotyczące czasu i wyboru poszczególnych metod diagnostycznych stosowanych w diagnostyce różnych scenariuszy zwichnięcia barku. Celem obrazowania w zwichnięciu stawu barkowego jest potwierdzenie zwichnięcia i jego kierunku, a na koniec udana redukcja. Zwykle służy to konwencjonalnej radiografii. Dodatkowo może być wymagane obrazowanie w celu identyfikacji uszkodzeń tkanek miękkich lub kości lub, w razie konieczności, uszkodzeń naczyń i nerwów, przy użyciu różnych metod (CT, MRI, USG). Selektywna ocena radiograficzna może zmniejszyć liczbę prześwietleń, koszty, a przede wszystkim czas przed redukcją i spędzenie przez pacjenta w nagłych wypadkach zjednoczyć. Należy to stosować ostrożnie, aby uniknąć błędnej diagnozy.

Author responsible for correspondence:
Przemyslaw Lubiatowski
Department of Traumatology, Orthopaedics and Hand Surgery
University of Medical Sciences in Poznań, Poland,
Sports Traumatology and Biomechanics Unit
Rehasport Clinic, Górecka 30, 60-201 Poznań, Poland
Email: p.lubiatowski@rehasport.pl
https://orcid.org/0000-0002-1011-981X

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Słowa kluczowe: zwichnięcie barku, obrazowanie, radiografia, niestabilność, rezonans magnetyczny, ultrasonografia, CT.

Introduction

Shoulder dislocation is a very common musculoskeletal injury. Imaging in such cases serves an important role in the diagnostic and therapeutic process. Despite a pretty simple clinical diagnosis, the process itself is long for the patient and associated with multiple steps and decision making to regain function with low risk of prolonged disability (Zygmunt *et al.,* 2013; Lubiatowski *et al.,* 2016). There are also many controversies as well as significant diversity among surgeons regarding the timing and choice of particular diagnostic modalities used in diagnostics of different scenarios of shoulder dislocation.

Aim of imaging in shoulder dislocation

The aim of imaging in shoulder dislocation is to confirm dislocation and its direction and finally successful reduction. This usually concerns acute situations before and after reduction. Complex dislocation may be accompanied by fractures of the glenoid or proximal humerus that also need to be identified on imaging. Most emergency management relies on conventional radiography, sometimes supported by computed tomography (CT-fractures, bone defects, locked dislocations).

Additionally, significant soft tissue injuries may occur and necessitate further diagnosis. That usually is performed in a delayed elective setting. Magnetic resonance (MR) helps diagnose a family of labral and capsular tears and rotator cuff lesions. The latter lesions may alternatively be evaluated by ultrasound scan (USG). On rare occasions, imaging serves to diagnose vascular (CT angiography, USG) and nerve injuries (USG, MRI).

Patients after dislocation may be at risk of various additional important lesions that may require a change in treatment (e.g., early surgery), and therefore require more sophisticated imaging. Several factors have been recognized that may help identify patients at such risk. Age is one of them. Patients over 45 y. o. are at risk of a concomitant cuff tear, which should always be suspected in case of dislocation in this age group. Age over 35 y. has been found to correlate with important fractures on dislocation. On the other hand, young patients (< 20 y.o.) are at high risk of recurrent instability following the first episode of dislocation. Surgeons may consider more adequate evaluation of labral tear and a chance of its healing (displaced vs. non-displaced), especially in the athlete population regarding either early return to sport or early surgical repair. Another group at risk is patients after high-energy trauma having a higher chance of shoulder comorbidities.

Imaging modalities

Conventional radiography

According to appropriateness criteria developed by the American College of Radiology for acute traumatic shoulder pain, conventional radiography is always the initial method of imaging and should include 3 X-ray views: anteroposterior in internal and external rotation and axillary or scapular Y view. Others recommend one AP view (true possibly), one axial (different modifications have been described), and one scapular (Y view) (Figure 1) (Amini *et al.,* 2018; Bonz *et al.,* 2015; Brems-Dalgaard *et al.,* 1990; Goud *et al.,* 2008; Neepa *et al.,* 2011).

X-ray allows not only for diagnosis of dislocation and effective reduction but also for diagnosis of fractures (glenoid rim, Hill-Sachs lesions, greater tuberosity) (Figure 2). The main advantages of conventional radiography include low cost, quick access, and low radiation level for the patient.

Computed tomography

CT serves best to evaluate fracture patterns, identification of minor injuries (glenoid rim

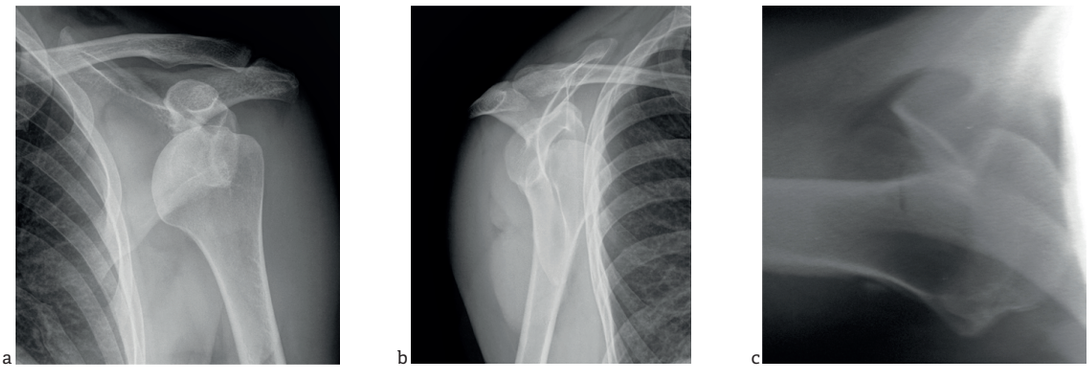

Figure 1. X-ray series in anterior shoulder dislocation (a – AP view, b – Y view, c – axillary view).

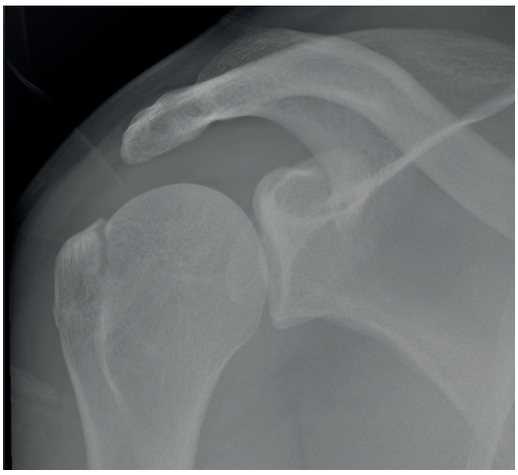

Figure 2. AP view image of non-displaced greater tuberosity fracture after reduced shoulder dislocation.

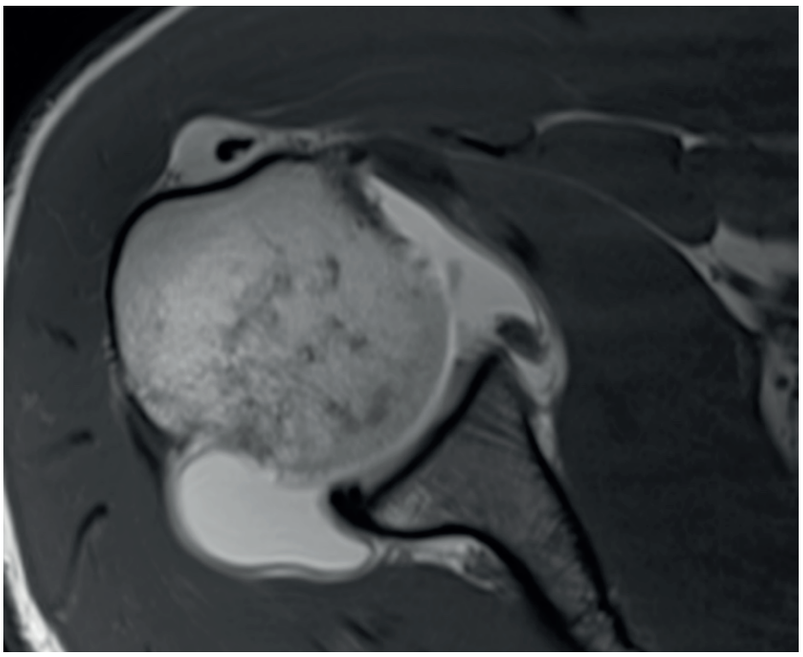

Figure 3. CT scan of locked anterior dislocation.

fractures or defects), and for the planning of surgical intervention (Figure 3) (Auffarth *et al.,* 2013; Lubiatowski *et al.,* 2016; Stefaniak *et al.,* 2020; Stefaniak *et al.,* 2020). The main advantages include:

- better accuracy of bone lesions then x-ray or MR- gold standard,
- possibility of multiplanar and 3D reconstruction for graphic depiction,
- cheaper and more accusable than MR,
- alternative to MR for patients with claustrophobia.

However, there are some disadvantages as well, including poor visualisation of soft tissue and significant radiation for the patient.

Magnetic resonance

MR allows for comprehensive evaluation of mostly soft tissues and, to a certain extent, for bone lesions (Chetouani *et al.,* 2010). It is rarely used in the acute setting, but in some cases can be used early with the advantage of hematoma serving as natural contrast delineating labral tear and possible displacement despite successful reduction and immobilization of the shoulder (Gyftopoulos *et al.,* 2012; Saupe *et al.,* 2008). MR arthrography (MRA) is usually used in chronic cases of persistent instability. General advantages of MR include:

- high resolution,
- graphic depiction of structures (report + images),
- no radiation,
- MR arthrography,
- highly accurate partial tears and labrum.

MR brings some disadvantages too:

- more expensive,
- takes longer to acquire,
- in may be contradicted in some cases: patients having metal implants, pacemakers, larger size, claustrophobia,
- quality of MR unit quality & MR technician,
- limited value for bone deformities,
- aMR- the need for accurate injection (time, cost, radiologist).

Ultrasonography

The US serves mostly to diagnose soft tissue injuries (that are not hidden under the bones). A case of shoulder dislocation is mostly rotator cuff tears, posterior labrum, and in rare cases, nerve (brachial plexus, axillary nerve) and vascular injuries. The US is rarely used in the acute setting, mostly in a delayed follow-up scenario. Several advantages of the US include:

- reasonable-to-high spatial resolution,
- easy access: portability, in-office, lower cost,
- no radiation (vs. CT),
- real-time and dynamic (impingement),
- preferred by patients vs. MR,
- contralateral comparison,
- US guided procedures.

US main disadvantages are few:

- not suitable for anterior and superior labrum evaluation,
- operator-dependent with a long learning curve.

In my experience, the US has great value when performed by an orthopedic surgeon in-office serving as an extension of clinical evaluation. This provides a quick diagnosis of major cuff tear when dislocation patients are followed later in an outpatient clinic. Basic skills are sufficient for such a diagnosis. However, if we demand a more detailed evaluation, usually a higher resolution scanner is required and far more skills from the operator. Usually, that is provided by a specialised musculoskeletal radiologist.

Standard vs. selective radiography in shoulder dislocation

The classic approach to use X-ray in dislocation is to perform the series before and after reduction of dislocation to confirm the diagnosis and successful reduction. However, it is associated with costs (X-ray, technician, doctor) and increases the time from dislocation to reduction. The latter may increase the patient's suffering and muscle spasm, making reduction more difficult. On the other hand, when we quit making radiographs

for dislocation, the most important risk is overlooking dislocation, missing fracture, or misjudging effective reduction. It has been reported that surgeons are convinced of diagnosis based on only clinical evaluation in 91% for dislocation and 93% of reduction. The risk of concomitant fracture in case of dislocation varies from 1.7–12%, and that mostly includes marginal glenoid and non-displaced tuberosity fractures (Dickens *et al.,* 2019; Gottlieb *et al.,* 2016; Gryfith *et al.,* 2008). That risk has been identified to affect mostly patients over 35 y. o., sustaining high energy trauma (fall from height, assault, motorcycle, sports trauma). Another risk is of a legal nature. Therefore, in the case of selective radiography, appropriate documentation is very important:

- after dislocation: pain, limited range of motion (locked shoulder), deformity,
- before reduction: pain relief, "unlocked" ROM, normal shape.

More official guidelines may also support decision-making from both a therapeutic and legal point of view.

The concept of selective radiography has been proposed in the literature. It suggests performing radiographic evaluation in patients at risk (direct, blunt trauma, unsure of the diagnosis, high energy > 35 y. o.). X-rays could be avoided, especially in cases of atraumatic dislocation or recurrence of instability. The concept has shown a 30–46% reduction of imaging in the emergency department. Selective radiography also reduced time spent in the emergency unit from 288 min. to 245 min. (when no pre-reduction X-ray was taken) or 150 min when neither pre- nor post-reduction was scanned. Despite the substantial reduction of imaging at emergency, they have not reported missed fractures in atraumatic dislocation. No important new fractures have been found after reduction. There were no cases of persistent dislocation. Surgeons were 100% accurate in clinically diagnosing dislocation, and correct reduction in no fracture was accompanying. However, in the presence of fracture/dislocation, accuracy to diagnose the dislocation was 98% and appropriate reduction 86%. Durak *et al.,* 2021, Emond *et al.,* 2004, Emond *et al.,* 2018, Handey at all 1996, Handey 2000, Handey *et al.,* 2006, Kahn at 2007, Orlovski *et al.,* 2011, Reid *et al.,* 2013, Shuster M *et al.,* 1999, Shuster *et al.,* 2002).

Therefore algorithm that could be proposed is currently discussed in Polish Shoulder and Elbow Society (Figure 4).

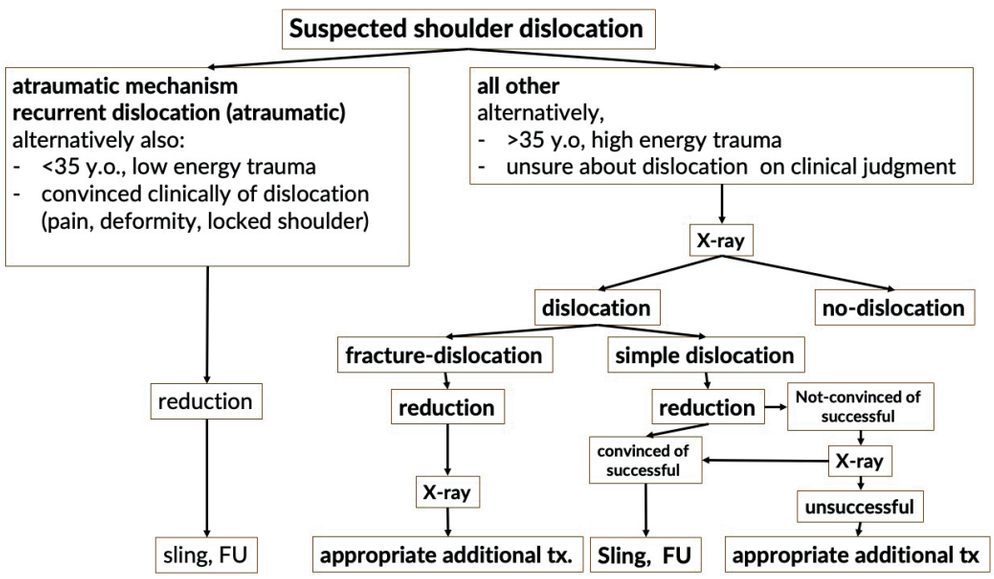

Figure 4. Algorithm for selective radiographic evaluation in shoulder dislocation (Tx. – treatment, FU – follow-up, y.o. – years old).

Some patients may require further diagnostic work-up after reduction, which include:

- fracture dislocation – mostly to evaluate fracture displacement and stability and consider the possibility of operative intervention; in some cases, diagnosis can rely on X-ray; for more accurate delineation, CT scan may be required (Dickens *et al.,* 2019),
- unsuccessful reduction or early redislocation- imaging is aimed to search for possible reasons of persistent dislocation (locked compression fracture, soft tissue interposition); depending on the clinical scenario, CT scan and/or MR may be required,
- patients with a high risk of recurrence (young, athletes, males) – in such cases, evaluation of labral tear may be considered the following reduction; MR scan is a method of choice in such circumstances; extent of labral tear, its morphology, and the position may be evaluated to predict the possibility of effective healing (Seybold *et al.,* 2009),
- patients > 45 y.o. – may require appropriate evaluation of rotator cuff status; that can be performed at early follow-up using an ultrasound scan or MR,
- accompanying vascular injuries- requires further imaging and clinical evaluation at the emergency unit (US scan, CT angiography),
- nerve/brachial plexus injuries- require further clinical evaluation after reduction, and in most cases, specialized care is provided later at follow-up supported by MR or ultrasound scan if needed.

Conclusions

The aim of imaging in shoulder dislocation is to confirm dislocation and its direction and finally successful reduction. That usually is served by conventional radiography. Additionally, imaging may be required to identify soft tissue or bone injuries or, when necessary vascular and nerve injuries. The selective radiographic evaluation may reduce the number of X-rays, costs, and most of all time before reduction and spent by patients in an emergency unite. That should be used carefully to avoid misdiagnosis.

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