Glenohumeral instability ultrasound in children with brachial plexus birth injury (BPBI)

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Learning objectives

The purpose of our educational exhibit is to:

1. Show the ultrasound technique and its usefulness for the posterior shoulder instability diagnosis in children with BPBI.
2. Report our experience in this kind of patients.

Background

Posterior glenohumeral instability is defined as posterior shift of the humeral head in relation to glenoid cavity.

Posterior instability of the humeral head is rare in childhood and in the most of cases is due to a BPBI. About the mechanic of development of this pathologic abnormality is proposed that a primary neural injury of the brachial plexus leads to muscle imbalance in the rotador cuff which results in internal rotation contracture of the arm and because of this will happen a glenohumeral deformity and posterior subluxation of the humeral head.

One-third of the infants and children with permanent BPBI will develop a posterior subluxation of the humeral head.

For posterior instability diagnosis there are different imaging techniques: ultrasound, magnetic resonance and computerized tomography.

The first one allows a dynamic assessment of glenohumeral instability and associated abnormalities in these patients. In addition, it has the advantage of being cost-effective and it requires no sedation. The disadvantages of ultrasonography are that it is dependent on the technical skills of the one performing the examination and the interpretation of the observer, besides it is unable to clearly define the anatomy of the anterior glenohumeral joint and the images obtained are not as detailed as those produced by MR or CT.

MR and CT are static techniques; they allow a better definition of the osseous and soft tissue anatomy and the dysplasia glenoid degree, which is necessary to know for therapeutic planning.
Early detection of shoulder instability is important to prevent deterioration of the glenohumeral joint and retroversion of the glenoid. Early detection allows the possibility of early treatment.

Loss of external rotation of the shoulder seems to be the best clinical indicator for posterior shoulder subluxation. The ultrasound can diagnose a posterior subluxation of the humeral head, before they are detected clinically. This finding suggested that US can be used a screening tool.

US should be performed only in patients with persistent symptoms of BPBI because none of the patients with a full recovery from the symptoms will develop shoulder instability.

The larger risk for shoulder instability in permanent BPBI is high during the first year of life.

**Findings and procedure details**

The ultrasounds of 52 patients with BPBI, which were performed in our department from January 2010 to November 2014, were analyzed retrospectively. Patient's age, clinical symptoms, reports and ultrasound images of each case were reviewed.

US of both shoulders were performed in all cases and high-frequency linear transducers (7-15 MHz) were used. The US technique (fig.1) included a static evaluation of glenohumeral joint congruency with the arm in neutral position and a dynamic evaluation with the arm in maximal internal and external rotation, by using a posterior axial approach. Posterior subluxation of the humeral head is assessed visually during the dynamic phase of the study.

Young infants (0-6 months in age) are placed on their side or hold by their parents. Children older (1 or more years old) are seated. Children are supported by a parent, who also holds the arm in the proper position.
**Fig. 1:** Glenohumeral instability. Ultrasound technique. A) Infant placed on their left side with the arm in neutral position. Posterior axial approach of glenohumeral joint. High-frequency transducers are used. B y C) Dynamic evaluation of glenohumeral joint with the arm in internal and external rotation.

**References:** - Málaga/ES

Posterior axial approach reveals the relationship between the humeral head and glenoid cavity, as well as the shape of the posterior glenoid.

The figure 2 shows the normal ultrasound anatomy of glenohumeral joint.
The following parameters of each case have been assessed:

Principal parameters (fig. 3 and 4):

- Epiphysis: morphology and size.
- Ossification center of humeral head: morphology and size.
- Scapular glenohumeral angle or alfa angle.

Posterior subluxation is assessed visually during the dynamic phase of the study and by measurement of the alfa angle or scapular glenohumeral angle. This one is the angle between the posterior margin of the scapula and the line drawn tangentially to the humeral head and posterior edge of the glenoid. The normal value of this angle is 30° or less. In the normal situation, the humeral ossification center is located anterior to the posterior margin of the scapula (the posterior scapular line). If the value of alfa angle is greater than 30°, it indicates subluxation posterior of glenohumeral joint. In this situation, should be assessed whether there is reduction of this with the external rotation. When the joint is reduced, the alfa angle is normalized and the humeral ossification center is located anterior to the posterior scapular line.

Other parameters (associated anomalies), fig 5 and 6:
• Glenoid dysplasia: Glenoid is considered dysplastic when it loses its normal angulation, it is retroverted or rounded.
• Muscle atrophy: Muscles are smaller and with signs of fat infiltration (hyperechoic)
• Winged scapula: The scapula is internally rotated and it is elevated
• Other: synovial cyst

The ultrasound allows to study the posterior margin of the glenoid. It can to determine the congruency of the humeral head with respect to this and detect early subluxation and glenoid deformity, but it cannot clearly define the degree of glenoid dysplasia.

Fig. 3: Principal parameters assessed: A) Normal morphology and size of humeral epiphysis (blue circle). Normal morphology, location and size of the ossification center of humeral head (yellow circle and red arrow). B) Scapular glenohumeral angle is the angle between the posterior margin of the scapular (line and red arrow) and the line drawn tangentially to the humeral head and posterior edge of the glenoid (green line). The normal value of this is 30° or less. If it is >30°, it indicates posterior subluxation of the glenohumeral joint.

References: - Málaga/ES
Fig. 4: Demonstrates two examples of posterior subluxation of the shoulder with the internal rotation (A and C images). In both cases, alfa angle is $>30^\circ$ and the ossification center is located posterior to the posterior scapular line. With the external rotation, there is not reduction in the B case and there is reduction in the D case. When there is reduction alfa angle is normalized and the ossification center is anterior to the posterior margin of the scapula.

References: - Málaga/ES
**Fig. 5:** Other parameters (associated anomalies): This figure shows different examples of dysplasia glenoid. A) It is the normal appearance of the cartilaginous glenoid (yellow arrow) and osseous glenoid (green arrow). B) Dysplasia of the posterior margin of the glenoid. This one is retroverted (yellow arrow) and it has lost its normal angulation (green arrow) C) Retroverted (yellow arrow) and rounded (green arrow) glenoid.

**References:** - Málaga/ES
**Fig. 6:** Other parameters (associated anomalies): A) It is the normal appearance of the deltoid and infraspinous muscles. B) The image demonstrates signs of the fat infiltration with hyperechoic muscles (yellow and red arrows) C) Panoramic view of both shoulders. Right shoulder shows the winged scapula with the scapula internally rotated and elevated (orange arrow). Note the greater distance from the scapula to the lung on the right side (green arrow). The left scapula is normal. D) There was a case with a synovial cyst (blue arrow).

**References:** - Málaga/ES

These are the results that have been obtained:

52 cases with BPBI --> The age of our patients was between one day and eight years old.
Fig. 7: 36 of the 52 patients showed glenohumeral stability and 16 patients showed instability with posterior subluxation of the humeral head.

References: - Málaga/ES

Fig. 8: There were 16 cases with glenohumeral instability. The mean age at diagnosis was 1 year and 6 months, but the 75% of our patients were diagnosed with less than one year old. 14 of 16 cases demonstrated reduction of the glenohumeral joint with the external rotation of the arm. About 60% of unstable joints showed signs of glenoid dysplasia and the ossification center and humeral head decreased.

References: - Málaga/ES

Fig. 9: There were 36 cases with glenohumeral stability. Just 8 of these patients had associated anomalies. About 20% of stable joints showed signs of muscular atrophy.

References: - Málaga/ES
Next, some cases are exhibited (figures 10 and 11)

**Fig. 10:** Case 1) A 4 months old girl with permanent left BPBI. Figures A and B exhibit a normal ultrasound right shoulder as much in internal rotation like in external rotation with alfa angle <30°. Figures C and D show posterior subluxation of the left shoulder (alpha angle >30°) without reduction in external rotation. The ossification center is anterior to the posterior margin of the scapula (yellow circle). In addition, there are signs of glenoid dysplasia with rounded and retroverted glenoid (green arrow).

**References:** - Málaga/ES
Fig. 11: Case 2) a 7 months old boy with permanent right BPBI. Figures A and C demonstrate posterior subluxation of the right shoulder (the yellow line indicates the posterior scapular line) with reduction in external rotation (figure D). The right ossification center is smaller than the left (red arrows in figures A and B). There are signs of glenoid dysplasia because the glenoid has lost its normal angulation (green arrow) and it is retroverted (orange arrow) and the muscular atrophy, the infraspinous and deltoid muscle are hyperechoic and with fat infiltration (yellow arrows in figure A).

References: - Málaga/ES

Images for this section:
**Fig. 1:** Glenohumeral instability. Ultrasound technique. A) Infant placed on their left side with the arm in neutral position. Posterior axial approach of glenohumeral joint. High-frequency transducers are used. B y C) Dynamic evaluation of glenohumeral joint with the arm in internal and external rotation.

**Fig. 2:** Transverse ultrasound image of normal left (A) and right (B) glenohumeral joint by using a posterior approach.
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<th>52 cases BPBI</th>
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<td><strong>36 cases</strong></td>
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<td><strong>16 cases</strong></td>
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Conclusion

Ultrasound is a tool that allows a dynamic assessment of glenohumeral instability and associated anomalies in patients with brachial plexus palsy before they are detected clinically, so it can be used as a screening technique.

Personal information

References
