ANALYSIS OF ROENTGENOLOGIC PARAMETERS OF THE ARTICULAR PROCESS OF THE SCAPULA IN CHILDREN WITH INSTABILITY OF THE SHOULDER JOINT

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Background. The frequency of occurrence of dislocation of the shoulder joint is the highest among that for all other limb joints. Simultaneously, recurrent instability of the shoulder joint develops majorly in children and adolescents, which, in the future, lead to the development of persistent pain syndrome. Past evidence indicate that the features of the spatial positioning of the articular process of the scapula can be considered as a risk factor toward the development of instability in the shoulder joint among adult patients. However, there is no reliable data in the literature regarding the influence of tilt and rotation of the shoulder blade glenoid on the occurrence of instability in the shoulder joint among children and adolescents. Encouraged, we undertook this subject for our study.

Aim. To clarify the impact of changes in the version and inclination of the glenoid on the instability of the shoulder joint among children.

Materials and methods. We analyzed the survey data of 42 children with a habitual dislocation of the shoulder of traumatic and atraumatic origins. The average ages of the examined children were 15.57 ± 1.75 and 15.07 ± 1.64 years, respectively, for those with shoulder instability of traumatic and atraumatic origins, respectively.

Results. Statistical data processing revealed no significant differences in the versioning and inclination of the glenoid process between the groups with traumatic and atraumatic instabilities of the shoulder joint. Notably, the average values of versioning and inclination indicators were in the normal range.

Conclusion. Based on our results, we suggest that, in the childhood, the dynamic and static soft tissue stabilizers of the shoulder joint play the leading role in the formation of instability of the shoulder joint among children.

Keywords: instability of the shoulder joint; recurrent dislocation of the shoulder; inclination; version; glenoid; children.
болевому синдрому. По данным литературы, особенности пространственного положения суставного отростка лопатки можно рассматривать как фактор риска развития нестабильности в плечевом суставе у взрослых пациентов. При этом отсутствуют достоверные данные о влиянии показателей, характеризующих пространственное положение суставного отростка лопатки, на возникновение нестабильности в плечевом суставе у детей и подростков, что и стало предметом нашего исследования.

**Цель** — уточнить влияние показателей изменения версии и инклинации суставного отростка лопатки на нестабильность плечевого сустава у пациентов детского возраста.

**Материалы и методы.** В работе представлен анализ результатов обследования 42 детей с привычным вывихом плеча травматического и произвольным вывихом атравматического генеза. Средний возраст обследованных детей составил 15,57 ± 1,75 и 15,07 ± 1,64 года для групп детей с нестабильностью плечевого сустава травматического и атравматического генеза соответственно.

**Результаты.** При статистической обработке данных достоверных различий показателей версии и инклинации суставного отростка лопатки между группами с травматической и атравматической нестабильностью плечевого сустава выявлено не было. Следует также отметить, что средние величины показателей версии и инклинации находились в диапазоне нормальных значений.

**Заключение.** В связи с этим можно предположить, что в возрасте 11–17 лет ведущую роль в формировании нестабильности плечевого сустава играют динамические и статические мягко-тканные стабилизаторы плечевого сустава.

**Ключевые слова:** нестабильность плечевого сустава; привычный вывих плеча; инклинация; версия; гленоид; ребенок.

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The incidence of shoulder joint dislocation is the highest among dislocations of other limb joints, as it accounts for 11.2 cases per 100 thousand people [1, 2]. Recurrent instability of the shoulder joint occurs in 96%–100% of pediatric and adolescent cases and can result in persistent pain syndrome with shoulder joint dysfunction. In some patients, shoulder joint instability progresses even without exposure to an acute trauma, and these patients represent approximately 1% of all patients with shoulder joint instability [3, 4].

Traumatic dislocation of the shoulder joint usually results from a force directed to the upper limb being in abduction and external rotation or from a direct impact on the shoulder joint in rare cases. Anterior dislocation accounts for 85%–95% of the cases [5].

Shoulder joint dislocations of non-traumatic origin are diagnosed more often at age 5–7 years. They are characterized by bilateral lesion and recurrent shoulder joint dislocations without traumatic cause, occurring in everyday life following mild trauma [6].

Shoulder joint instability can be caused by the dysplastic fibrous lip of the scapular articular process, with the hypoplastic nature causing instability of atraumatic origin. Shoulder joint instability of traumatic origin is caused by lesions in the soft tissue stabilizers of the shoulder joint, such as ligaments, articular lip, shoulder capsule, and biceps tendon [7–9].

According to relevant literature, the peculiarities of the spatial position of the scapular articular process can be considered risk factors for the anterior instability of the shoulder joint [10–12].

The spatial position (or deviation) of the scapular articular process is considered in two planes. First, the anterior or posterior rotation (anteversion or retroversion) of the articular process is assessed in the horizontal plane relative to the axis of the scapular body. Normally, it ranges from 2° of anteversion to 9° of retroversion [4, 13]. Data on the glenoid posterior deviation indicate this as a significant anatomical predisposing factor to the development of posterior shoulder joint instability [7–9].

Second, the position of the scapular articular process, i.e., its inclination, is analyzed. This is a deviation in the inferior–superior direction in the vertical plane relative to the axis of the scapular body, which normally varies from 7.0° of the upper inclination to 15.3° of the lower inclination. According to Rouleau et al. [14], the inclination of the scapular articular process beyond the normal range can influence the development of instability and represent a risk factor for the damage to the intra-articular structures of the shoulder joint [4, 9, 13].

Churchill et al., Rouleau et al., and Inui et al. [4, 13, 14] have recommended the use of digital radiography, computed tomography (CT), or magnetic resonance imaging (MRI) to assess the
spatial relationships of bone structures in the shoulder joint [4, 13, 14].

In view of the data presented, there is a need to clarify the causes and anatomical changes of the scapular articular process and to address the lack of reliable data on the effect of inclination and rotation of the scapular articular process on the occurrence of shoulder joint instability in children and adolescents.

This study aimed to clarify the influence of indicators of change in the version and inclination of the scapular articular process on the occurrence of shoulder joint instability in pediatric patients.

Materials and methods

This study analyzed the results of examination of 42 children with recurrent shoulder dislocation of traumatic origin and arbitrary shoulder dislocation of atraumatic origin, who had undergone surgery in the period from 2018 to 2019. The patient age ranged from 11 to 17 years. Two groups were formed, namely, the group of 28 patients with traumatic instability of the shoulder joint (TISJ) and the group of 14 patients with atraumatic instability of the shoulder joint (AISJ). The groups did not differ significantly by sex, age, and side with the lesion.

Magnetic resonance, computed tomography, and statistical methods were used in the study.

MRI was performed using Philips Panorama HFO 1.0 T MRI System (Philips, USA), and the standard protocol included proton-weighted pulse sequences with suppression of the signal from adipose tissues, T2-weighted images, and T1-weighted images in the sagittal, axial, and coronal views. The slice thickness was 3 mm. Multispiral CT (MSCT) was performed using Philips Brilliance KT 64 Slice CT scanner (Philips, USA), and sections were made in the axial and frontal views.

Digital CT and MRI images were analyzed with an assessment of the parameters characterizing the spatial position of the scapular articular process.

1. The version of the scapular articular process (inclination of the scapular articular process in the anterior–posterior direction) was assessed by MSCT using the method proposed by Friedman et al. [15]. Line 1 in the axial section passing through the center of the scapular articular process was drawn through its anterior and posterior extreme points (AB). Line 2 was drawn between the midpoint of the glenoid fossa and the medial end of the scapular body (CD). Then, the angle of the glenoid version was calculated by subtracting 90° from angle \( \alpha \) (the angle between lines 1 and 2). If the resulting angle has a negative value, the scapular articular process is in the retroversion position, and if the value is positive, the scapular articular process is in the anteversion position (Fig. 1).

2. Inclination (tilt of the scapular articular process in the superior-inferior direction) was assessed...
using MRI data according to the method proposed by Maurer et al. [16]. A coronal oblique image showing the deepest point of the supraspinous fossa of the scapula was selected. Line 1 was drawn between the utmost upper and lower points of the scapular articular process (AB), and line 2 was drawn through the deepest point of the supraspinous fossa along the axis of the scapular body (CD). Then, the glenoid angle of inclination was calculated by subtracting 90° from angle \( \alpha \) (the angle between lines 1 and 2). Positive and negative values of the resulting angle indicate caudal inclination (inferior) and cranial inclination (superior), respectively (Fig. 2).

Statistical analysis was performed using MS Excel 2019 (Microsoft Corporation, Redmond, WA) and SPSS v.23 (IBM Corp., Armonk, NY). The level of significant differences was assessed by the Mann–Whitney U-test.

**Results**

Table 1 presents the obtained values of the version and inclination of the scapular articular process according to MSCT and MRI data in patients with TISJ and AISJ.

In the data analysis, the Mann–Whitney U-test did not reveal significant differences in the version and inclination indices of the scapular articular process between patients with TISJ and AISJ. According to Churchill et al. [13], the mean values of the version and inclination indices are within the range of normal values (Table).

**Discussion**

In the adult population, a relationship was found between the spatial position of the scapular articular process and the development shoulder joint instability. Wirth et al. [17] demonstrated the influence of excessive retroversion on the development of recurrent posterior shoulder joint instability. In case of caudal inclination of the scapular articular process, the risk of anterior–posterior displacement of the humeral head during dislocation is potentially higher. Cranial inclination may be a risk factor for supraspinatus tendon injury [18–20]. In addition, the efficacy of corrective osteotomies for treating shoulder joint instability to align the version of the articular process is questionable [21]. Moreover, no studies have investigated the spatial relationships of bone structures in TISJ of pediatric patients with shoulder joint instability.

**Conclusion**

In this study, we analyzed the values of the version and inclination of the scapular articular process in pediatric patients with traumatic and atraumatic instability of the shoulder joint. No significant differences were found in these indicators, both between groups of patients with different pathogenesis of instability and their standard values. This finding suggest that at age 11–17 years, dynamic and static soft tissue stabilizers of TISJ have a dominant role in the development of shoulder joint instability. Generalization of the results is limited due to the age restriction of the study sample as well as the lack of standard values of indicators characterizing the spatial position of the scapular articular process in pediatric population.

Thus, the influence of the spatial position of the scapular articular process on the development of shoulder joint instability in pediatric patients requires further investigation.

<table>
<thead>
<tr>
<th>Indicators and MRI data</th>
<th>TISJ (M ± SD)</th>
<th>AISJ (M ± SD)</th>
<th>Reference values (Churchill et al. 2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version of the scapular articular process (Friedman et al.)</td>
<td>(-6.29 \pm 4.97)</td>
<td>(-7.14 \pm 9.96)</td>
<td>(-9.50–10.50)</td>
</tr>
<tr>
<td>Inclination of the scapular articular process (Maurer et al.)</td>
<td>(-6.74 \pm 5.78)</td>
<td>(-7.14 \pm 9.96)</td>
<td>(-7.00–15.30)</td>
</tr>
</tbody>
</table>

**Note.** AISJ, atraumatic instability of the shoulder joint; TISJ, traumatic instability of the shoulder joint.
Additional information

Source of funding. The study had no external funding.

Conflict of interests. The authors declare no conflict of interest.

Ethical statement. The study was discussed and approved by the local ethics committee of the Turner Scientific and Research Institute for Children's Orthopedics (protocol No. 20-1 of 04/27/2020). Patients and their legal representatives gave informed consent for examination, treatment, publication of research results in scientific literature, and use of information for educational process and other purposes.

Author contributions

Ya.N. Proshchenko formulated the research concept and design, selected and processed the data, and wrote the article.

S.A. Lukyanov selected and processed the data, and wrote the article.

All authors have made significant contributions to the research and preparation of the article and have read and approved the final version before its publication.

References


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