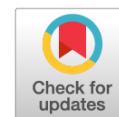


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Original Study Article



# Comparative evaluation of the sensitivity and specificity of clinical and magnetic resonance methods of assessing damage to the fibrocartilage lip in pediatric patients with traumatic instability of the shoulder joint

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**BACKGROUND:** The shoulder joint provides the greatest degree of freedom in movement, making it one of the most unstable and frequently dislocated joints, accounting for almost 50% of large-joint dislocations. Recurrent instability of the shoulder joint develops in 96%–100% of children and adolescents, making it important to accurately diagnose possible anatomical causes of persistent pain syndrome violating the habitual function of the shoulder. At the same time, the symptoms of intra-articular injuries of the shoulder joint are often vague, and a definitive diagnosis cannot be made without the use of instrumental research methods.

**AIM:** To compare the diagnostic value of clinical examination and magnetic resonance imaging in detecting intra-articular pathology in adolescents with anterior instability of the shoulder joint of traumatic origin.

**MATERIALS AND METHODS:** This retrospective study included parameters of clinical examination and instrumental methods of investigation of 72 children (72 shoulder joints) with habitual shoulder dislocation of traumatic origin. The age of the examined persons ranged from 13 to 17 years.

Magnetic resonance, clinical, arthroscopic, and statistical methods of research were employed in this work. The arthroscopic method was considered as a reference research method for assessing the sensitivity and specificity of clinical examination and magnetic resonance imaging. Sensitivity and specificity were evaluated, followed by an assessment of the prognoses of positive and negative results for MRI data and clinical research methods.

**RESULTS:** The MRI data was characterized by a significantly greater sensitivity and specificity in detecting lesions (95.4% and 71.4%) than those of clinical examination (79.1% and 60%). Thus, MRI is better at detecting damage to the fibrous-cartilaginous lip in traumatic instability in adolescents than clinical examination.

**CONCLUSIONS:** In our opinion, for the most reliable preoperative planning of surgical treatment of children, a full-fledged clinical examination should be used and data from instrumental research methods should be included, considering the advantages and disadvantages of each method.

**Keywords:** shoulder dislocation; child; arthroscopy; Bankart injury; clinical examination; MRI.

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Оригинальное исследование

## Сравнительная оценка чувствительности и специфичности клинического и магнитно-резонансного методов исследования для выявления повреждения фиброзно-хрящевой губы у подростков с травматической передней нестабильностью плечевого сустава

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**Обоснование.** Плечевой сустав обеспечивает наибольшую степень свободы в движении и является одним из наиболее нестабильных и часто вывихиваемых суставов. На его долю приходится почти 50 % всех вывихов крупных суставов. Рецидивирующая нестабильность плечевого сустава, по данным ряда авторов, развивается в 96–100 % у пациентов детского и подросткового возраста. При этом важно точно диагностировать возможные анатомические причины, приводящие к стойкому болевому синдрому, нарушению функции сустава и привычному его вывиху. В то же время симптомы внутрисуставных повреждений плечевого сустава часто бывают недостаточно четкими и диагноз может быть не ясным без применения инструментальных методов исследования.

**Цель** — сравнить диагностическую ценность клинического обследования и магнитно-резонансной томографии для выявления повреждений суставной губы у подростков с передней нестабильностью плечевого сустава травматического генеза.

**Материалы и методы.** Ретроспективное исследование включало сравнение результатов клинического обследования и инструментальных методов исследования у 72 подростков (72 плечевых сустава) с привычным вывихом плеча травматического генеза. Возраст обследованных составил от 13 до 17 лет.

В работе были использованы магнитно-резонансный, клинический, артроскопический и статистический методы исследования. Артроскопический метод являлся референтным для оценки чувствительности и специфичности клинического обследования и магнитно-резонансного метода исследования. Определены чувствительность и специфичность с последующей оценкой прогностичности положительного и отрицательного результатов для данных магнитно-резонансной томографии и клинического метода.

**Результаты.** Данные магнитно-резонансной томографии в нашей работе характеризовались большей чувствительностью и специфичностью с большей статистической значимостью (95,4 и 71,4 %), чем чувствительность и специфичность клинического обследования (79,1 и 60 %). Магнитно-резонансная томография позволяла лучше выявлять повреждения фиброзно-хрящевой губы при травматической нестабильности у подростков в сравнении с клиническим исследованием.

**Заключение.** Для наиболее качественного предоперационного планирования хирургического лечения подростков с привычным передним вывихом плеча следует обязательно дополнять клиническое обследование инструментальными методами.

**Ключевые слова:** вывих плеча; ребенок; артроскопия; повреждение Банкарта; клиническое обследование; магнитно-резонансная томография (МРТ).

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## BACKGROUND

The shoulder joint provides the greatest degree of freedom of movement and is one of the most unstable and frequently dislocated joints in the body, accounting for almost 50% of all large joint dislocations [1]. An emergency trauma service providers usually provide initial treatment and evaluation of these injuries using standard radiographs followed by closed reduction and immobilization. Concurrently, several authors stated that recurrent shoulder joint instability develops in 96%–100% of patients in childhood and adolescence and can lead to persistent pain syndrome with impaired shoulder joint function [2, 3]. Additionally, upon history taking, pediatric patients report severe pain syndrome, dysfunction, and, to a lesser extent, recurrent shoulder joint dislocations. The clinical examination in many cases revealed not sufficiently informative symptoms of intra-articular injuries; thus, the diagnosis must be clarified and instrumental methods should be applied.

Damage to the articular lip, scapulohumeral ligaments, and the rotator cuff reduces the efficiency of conservative treatment and can lead to recurrent shoulder joint instability.

Studies on adult patient examinations demonstrated clinical and instrumental study results, such as magnetic resonance imaging (MRI). Few studies focused on a comprehensive assessment of the accuracy of clinical tests and MRI for intra-articular pathology diagnostics in pediatric patients with shoulder joint instability [4–6].

**The work aimed** to compare the diagnostic value of clinical examination and MRI for detecting fibrocartilagenous lip damage in adolescents with habitual shoulder dislocation.

## MATERIALS AND METHODS

This retrospective study compared the results of clinical and instrumental studies of 72 pediatric patients (72 shoulders) with shoulder habitual dislocation of traumatic origin who are admitted for arthroscopic shoulder joint stabilization from 2018 to 2020. The age of examined patients ranged from 13 to 17 years. The average age of patients at the time of surgical treatment was  $15.7 \pm 1.08$  years (13–17 years). The study group included 58 males and 14 females.

The work used MRI, clinical, and statistical methods. The arthroscopic method was the reference method for assessing the sensitivity and specificity of the clinical examination and MRI.

The clinical examination included an overall range of motion assessment, upper limb strength, and diagnostic tests for specific intra-articular shoulder pathology [7–9]. Shoulder joint instability tests were considered, which assess fibrocartilagenous lip damage of the articular process of the scapula. The Sulcus test was performed to

diagnose [10, 11] inferior instability (groove formation under the acromial process of the scapula during downward upper limb traction), and anterior [12] and posterior [13] drawer tests were used to determine anterior and posterior instability (humeral head translation with a fixed shoulder joint with pressure on the humeral head in the anterior or posterior direction). Patients with at least one of the above symptoms of shoulder joint instability and damage to the cartilaginous lip of any localization the clinical examination result was considered positive.

MRI was performed on a Philips Panorama HFO 1.0 T device (Philips, USA), the standard protocol included proton-weighted pulse sequences with signal suppression from adipose tissue, and T2-weighted images (WI), T1-WI in sagittal, axial, and coronal views. The slice thickness was 3 mm. A positive result was articular lip damage detection, and a negative result was the absence of damage.

Diagnostic arthroscopy was performed by one surgeon during surgical shoulder joint stabilization to identify intra-articular pathology and choose the scope of surgical intervention.

The following are indications for surgery:

- multiple (>1) involuntary shoulder joint dislocations with an indication in the history of trauma with or without signs of lip segment tears;
- pain syndrome in the shoulder joint, which did not regress after conservative treatment.

Arthroscopic examination within the diagnostic stage of surgical intervention was performed through a standard posterior approach, while the patient was under general anesthesia in the lateral position with applied traction for the abducted upper limb.

The articular lip damage localization was assessed using the clock face scheme, where the 12 o'clock position was the highest point of the articular process of the scapula. Isolated anterior labral lesions were noted within the 2–6 o'clock position for the right shoulder and the 10–6 o'clock position for the left shoulder; while upper labral lesions were detected within the 10–2 o'clock position. Posterior labral lesions were revealed within the 6–10 o'clock position for the right shoulder and the 6–2 o'clock position for the left shoulder.

The visualization results during arthroscopy were documented, considering the presence or absence of fibrocartilagenous lip damage. The intraoperative results were then compared with the preoperative MRI results (which were presented and described by the radiologist before the surgical treatment) and the preoperative clinical examination data.

The data were analyzed using the Statistical Package for the Social Sciences version 23.0 software (SPSS IBM Inc., Chicago, Illinois).

The clinical method and MRI data determined true-positive and true-negative results, using both the evaluated

and reference methods, and false-positive and false-negative results, wherein the result was negative using the evaluated method and positive using the reference method. Positive results for the clinical method were considered as the presence of at least one positive result of a clinical test for shoulder joint instability. MRI was used to assess articular lip damage. The method accuracy was calculated as the percentage of the sum of true-positive and true-negative results, the sensitivity as the percentage of the number of true-positive results, and the specificity as the percentage of the number of true-negative results to the total number of patients.

The statistical data were initially evaluated using descriptive statistics methods. Sensitivity and specificity were also assessed, followed by estimation of positive and negative predictive values for MRI data and clinical methods.

A chi-square test was performed to compare the clinical examination and MRI results with those of arthroscopy, and the capabilities of these methods to detect labrum tears were analyzed. *P*-values of  $\leq 0.05$  was used to determine the significance of all statistical tests.

## RESULTS

The study group included 72 patients based on the previously specified criteria. The right upper limb injury was most frequently registered (65% of cases).

X-ray examination revealed no signs of bone-traumatic injuries in any of the patients.

Neither clinical, arthroscopic, nor MRI examinations showed intra-articular structure damage of the shoulder joint, in addition to the cartilaginous lip damage in the anterior sections, in any of the examined patients. Hence, all the data below relate to this particular type of damage (Table).

The clinical examination data compared with arthroscopic data revealed an 80% accuracy, 79.1% sensitivity, 60% specificity, and 96.4% positive predictive value ( $p = 0.046$ , Pearson's chi-square test).

MRI findings compared with arthroscopic data revealed a 93% accuracy, 95.4% sensitivity, 71.4% specificity, and 96.9% positive predictive value ( $p < 0.001$ , Pearson's chi-square test).

Notably, significantly more patients without symptoms of articular lip damage were determined according to the clinical examination (19.4%) than MRI (4.1%).

## DISCUSSION

Instability type identification is not difficult based on history, clinical examination, and radiological studies. However, accurate intra-articular pathology verification is a more complicated task, of which the solution significantly affects the preoperative planning quality, which in turn may influence the surgical treatment results.

Our study results revealed that the MRI study has higher sensitivity and specificity with greater statistical significance (95.4% and 71.4%) compared to the clinical method (79.1% and 60%). Concurrently, MRI data are characterized by greater sensitivity than specificity. From our point of view, clinical examination that revealed significantly more false-negative results than MRI (19.4% vs. 4%) is very important.

The literature presents a few publications that analyze the sensitivity and specificity of the clinical method and MRI in pediatric patients, while concurrently, a significant number of publications describe similar studies in adult patients. Moreover, the data obtained by comparing the specificity and sensitivity of the clinical method and MRI are contradictory.

Farber et al. [14] studied the diagnostic value of clinical tests for assessing articular lip injuries in case of shoulder joint instability of traumatic origin, confirmed by arthroscopy in adult patients. The clinical examination revealed an accuracy of 93%, a sensitivity of 48%, and a specificity of 99%. Liu et al. [15] analyzed the data from the examination of 54 patients with a mean age of 34 years and the results of clinical examination and MRI in patients with suspected articular lip injuries. They revealed an 89% accuracy of the physical examination, while the MRI was only 65%. Imhoff et al. [16] analyzed the correlation between MRI and arthroscopy and revealed an 87% accuracy, 69% sensitivity, and 100% specificity in MRI.

Tortensen et al. established that articular lip injuries were identified with 62% accuracy [17], 73% sensitivity, and 58% specificity using MRI (values of the indicators were lower compared to our study). Momenzade et al. revealed that MRI

**Table.** Comparative evaluation of the clinical, magnetic resonance imaging, and arthroscopic results

Methods compared	TP ( <i>n</i> , frequency in %)	TN ( <i>n</i> , frequency in %)	FP ( <i>n</i> , frequency in %)	FN ( <i>n</i> , frequency in %)	Total ( <i>n</i> , frequency in %)
Clinical examination — arthroscopy data	53 — 73.6	3 — 4.2	2 — 2.8	14 — 19.4	72 — 100
MRI study — arthroscopy data	62 — 86.2	5 — 6.9	2 — 2.8	3 — 4.1	72 — 100

Note. TP: true-positive results; TN: true-negative results; FP: false-positive results; FN: false-negative results.

has low sensitivity and moderate specificity in detecting the Bankart lesion [16].

Polster et al. explained the potentially low sensitivity of MRI in detecting Bankart lesions [18] because large differences in the type and position of Bankart lesions, close location, and adjacency of the upper articular lip to the capsule and cortical bone, with the same signal intensity, complicate their identification.

Our study results differ from those in the adult population regarding the sensitivity and specificity of the clinical method. Accuracy, specificity, and sensitivity indices in the clinical examination were higher in the adult population because patients in the pediatric population did not fully understand the course of the clinical examination and misinterpreted their complaints. However, we do not fully agree with the interpretation of this feature in pediatric patients, as proposed by Eisner et al. [19], where the authors explain the lower efficiency of the clinical examination because patients tend to conceal the severity of their condition to return quickly to their habitual physical activity level. This problem is not relevant in our case because patients were admitted to the department after a preliminary outpatient consultation, and they knew about the upcoming surgical treatment. However, additional studies are required to more accurately verify the causes resulting in a decreased clinical method efficiency in adolescent patients.

Therefore, our study confirms that MRI has greater sensitivity and specificity in detecting lesions of the fibrocartilage lip in the case of traumatic instability in adolescents compared to the clinical method despite the conflicting literature data.

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## CONCLUSION

We revealed that the efficiency of detecting the glenoid lip damage of the shoulder joint of traumatic origin in habitual shoulder dislocation in children is higher using MRI than clinical examination.

The selection of an adequate treatment approach requires a complete physical examination and the use of findings of instrumental methods, considering the advantages and disadvantages of each.

## ADDITIONAL INFORMATION

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

**Ethical considerations.** Protocol No. 20-3 of the meeting of the local ethics committee of the H.I. Turner National Medical Research Center for Children's Orthopedics and Trauma Surgery dated 11/20/2020.

The patients (their representatives) submitted their consent to the processing and publication of personal data.

**Author contributions.** Ya.N. Proshchenko developed the research design and wrote the article text. S.A. Lukyanov wrote the text of the article and performed the literature search. A.G. Baindurashvili developed the research design and edited the text of the article.

All authors made a significant contribution to the study and article preparation, as well as read and approved the final version before its publication.

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