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Clinical Practice

Radial head subluxation in pediatric clinics and emergency departments in China

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ABSTRACT

Purpose: To investigate the characteristics of the onset and treatment of radial head subluxation (RHS) in pediatric clinics and emergency departments.

Methods: A retrospective study was performed on 11, 404 RHS cases in 9827 children who visited pediatric clinics and emergency departments from January 2015 to December 2018. The patients who with history of trauma and fracture of the affected limb were excluded. The following factors were examined: the mechanisms of RHS, the type of manual reduction, the attending physician's clinical background (emergency surgeon, junior pediatric orthopedic surgeon or senior pediatric orthopedic surgeon), and the epidemiological features (gender, age, climate and location) of the injury.

Results: The mean age of the patients was 27.93 ± 17.94 months (range 0.93–214.53 months), with a peak incidence of 10.73–44.53 months. Approximately two-thirds of RHS cases occurred in cold weather from January to March and from September to December. Females accounted for 53.81% ($n = 6137$) of the cases, and left injuries were predominant (56.87%, $n = 6485$) in all cases. Mechanisms of injury were classified as "pull" (90.57%, $n = 10, 339$), "fall" (1.56%, $n = 178$), "hit" (0.75%, $n = 86$) and "unknown" (7.02%, $n = 801$). The overall success rate of manual reduction was 99.47%, and the success rate of reduction was higher for senior pediatric orthopedic surgeons than for emergency surgeons and junior pediatric orthopedic surgeons ($p < 0.05$). However, there was still a recurrence rate of 12.16% in the 9827 patients.

Conclusion: Younger children are predisposed to RHS, and there is a possibility of recurrence. Trained emergency doctors can handle it well, but it is essential to refer patients to specialists when manual reduction failed.

Introduction

Radial head subluxation (RHS) is a common complaint seen in pediatric clinic and emergency department. According to the study of Schunk and Macias, RHS occurs most often in children aged 6 months to 4 years old and is slightly predominant in girls and in the left arm in the United States.[1,2] RHS usually result from a pulling or axial traction to an extended arm; therefore, RHS is also known as nursemaid's elbow, pulled elbow, or temper tantrum elbow.[3] This condition was easily reduced with supination at the wrist followed by flexion at the elbow, and complication is rare except for recurrence.

In this retrospective study, we described our 4 years experience in pediatric clinic and emergency department, and examined the patient's age of onset, gender, location and mechanism of injury, seasons, rate and frequency of recurrence. In addition, we examined the factors associated with the success rate of manual reduction and the different clinical background of doctors, including the practice patterns of emergency surgeons, junior pediatric orthopedic surgeons and senior pediatric orthopedic surgeons.

The limitation of the study is that the epidemiological data currently available for the Chinese population do not have sufficient coverage. The cases included in this study were from a single Chinese university hospital from January 2015 to December 2018.

Methods

The study reviewed 11, 404 RHS cases in 9827 children who visited the pediatric clinic and emergency departments from

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January 2015 to December 2018. There were 5267 (46.19%) cases in males and 6137 (53.81%) in females. Overall, 6485 (56.87%) cases involved the left arm, and 4919 (43.13%) cases involved the right arm; among these cases, there were 12 children with bilateral RHS.

There were 9827 patients who initially visited pediatric clinics and emergency department, and the attending doctors included emergency surgeons, junior pediatric orthopedic surgeons and senior pediatric orthopedic surgeons. The most common reasons for the visit including: limited mobility after pulling the upper limbs, limited upper limb activity after falling, and unexplained limited upper limb activity. After inquired the patients' medical history and conducted the relative physical examinations, patients who were suspected with upper extremity fractures or clavicle fractures were required to undergo radiographic analysis. After the possibility of fracture was excluded, manual reduction was performed by the visited doctor. Traditional methods of manipulation reduction including the supination-flexion (SF) maneuver and the hyperpronation (HP) maneuver.[4] When a patient's elbow showed clinical improvement in joint activity after outpatient observation stay for 15 mins, successful manual reduction was confirmed. After that we trained the child patient's guardian to watch for some behaviors in daily life, such as avoiding pulling the forearm during play or when the child fell down, choosing loose and open-fitting clothing and dressing and undressing the affected limb first. Otherwise, if manual reduction failed, the patients need to be referred to a pediatric orthopedic surgeon.

In the study period, 1436 patients initially visited the pediatric orthopedic clinic or emergency department, and were seen by senior pediatric orthopedic surgeons. The same assessment and treatment were performed. As the physicians did in emergency department, some reductions performed by the senior pediatric orthopedic surgeons also have probability of failure. Radiography was needed, when reductions failed. If there is no other problem, such as fracture, manual reduction needed to be performed again by other attending doctor or senior surgeon.

Statistical analysis was performed in SPSS 22.0. All variables were converted into count data and compared using a chi-squared test, and binary logistic regression was performed to study the risk factors. The level of statistical significance difference was set at $p < 0.05$.

Results

The mean age of RHS onset was 27.93 ± 17.94 months (range 0.93–214.53 months), and approximately 75% occurred between 10.73 and 44.53 months old, as shown in Fig. 1. The mean age of RHS onset in males was 28.45 ± 18.46 months (range 1.13–194.30 months) and it was 27.47 ± 17.47 months (range 0.93–214.53 months) in females, as shown in Fig. 2.

Mechanisms of injury were classified as “pull” (90.57%, $n = 10339$), “fall” (1.56%, $n = 178$), “hit” (0.75%, $n = 86$) and unknown (7.02%, $n = 801$). The “pull” group including the patients whose upper limbs were pulled by others. The “fall” group including patients with any cause of falls where the upper limbs touch the ground first. The “hit” group including patients who were hit, squeezed, beaten, and any other actions led to arm thrusted. The patients were unsure how they were hurt remind in the group of unknown. ANOVA was performed, and the age of RHS onset for patients with different mechanisms of injury was reviewed (Table 1). The age of onset for the mechanism “fall” was 34.21 ± 24.94 months, which was greater than those of the “pull” ($p < 0.001$), “hit” ($p = 0.006$) and “unknown” ($p < 0.001$) mechanisms. However, there was no significant difference among the “pull”, the “hit” and the “unknown” groups ($p > 0.05$).

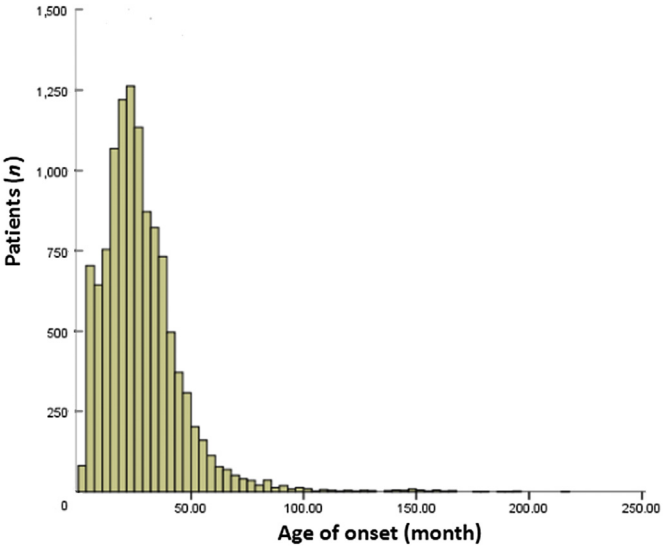

Fig. 1. The age of RHS onset in this study.

For these patients, 11, 465 manual reductions were performed by emergency surgeons, or by junior or senior pediatric orthopedic surgeons. The reduction failed in 61 cases, in which the children did not resume use of the affected arm within 15–30 min. The success rate of manual reduction was 99.47% in total. The success rate of manual reduction for doctors with different clinical background was shown in Table 2. Senior pediatric orthopedic surgeons had a higher success rate than other surgeons ($p < 0.05$).

There were 1195 patients who had at least 1 relapse, and 5 patients had 5 relapses. The relapse/recurrence rate of RHS was 12.16% in 9827 patients, as shown in Table 3. Interestingly, 1 patient suffered bilateral RHS initially and then had a relapse in each arm.

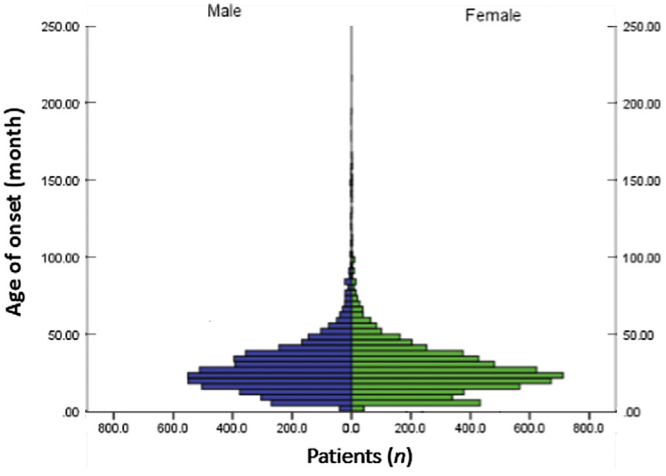

Fig. 2. The difference in the onset of RHS between males and females.

Table 1
The age of radial head subluxation with different mechanisms (month).

Mechanisms of injury	Age (mean, range)	*p* value
Pull	27.83 ± 17.48, 0.93–214.53	<0.001
Fall	34.21 ± 24.94, 6.40–159.97	
Hit	27.75 ± 23.20, 2.57–166.87	
Unknown	27.78 ± 20.82, 3.57–194.30	

Table 2
The success rate of manual reduction performed by doctors with different clinical background, *n* (%).

Surgeons	Results		*p* value
	Success	Fail	
Emergency surgeon	9289 (99.42)	54 (0.58)	0.034
Junior pediatric orthopedic surgeon	679 (99.27)	5 (0.73)	
Senior pediatric orthopedic surgeon	1436 (99.86)	2 (0.14)	

Table 3
The rate of recurrence of radial head subluxation.

Recurrence (times)	*n* (%)
1	915 (76.57)
2	212 (17.74)
3	52 (4.35)
4	11 (0.92)
5	5 (0.42)

It is worth notice that 163 patients had attempted manipulative reduction by themselves. Their elbow joint activity was normal when they was visiting, nonetheless, the patients' guardians insisted that there was limited mobility or pain after pull the upper limbs of their children. However, these patients were divided into another group and were compared with the cases studied before. The recurrent cases tended to be cases of attempted self-reduction ($p = 0.004$), and there was no significant correlation between gender and age, as shown in Table 4.

Furthermore, among these 163 cases of self-reduction, 32 had a history of recurrence, 11 had of them attempted self-reduction at the first time of onset and then experienced recurrence, and the other 21 had attempted self-reduction at the time of recurrence. The emergency surgeons evaluated the treatment based on the guardians' subjective description; thus, there was doubt regarding the reliability of the medical history.

Discussion

RHS occurs more frequently in younger children and has a different age of onset in different countries. The study covered an age range from 0.93 months to 214.53 months with a peak incidence from 10.73 months to 44.53 months, and the peak incidence was slightly different from the peak incidence of previous reports which was from 2 to 3 years old in both Europeans and Americans.[1] A possible reason for this difference is that children in China have different individual characteristic such as dietary pattern, compared with other nations. Therefore, it is noticeable that dietary differences have a strong influence on the skeletal growth and development of young children. It is recognized that Chinese eating habits have shifted from a traditional diet to a high-fat, low-carbohydrate and low-fiber diet. In contrast to the European high-energy, high-fiber, high-mineral and high-vitamin diet, this shift may be one of the factors causing differences in the age of onset.[5]

Table 4
The difference between manual reduction cases and self-reduction cases.

Variables	Manual reduction	Self-reduction	*p* value
Gender (*n*)			0.841
Male	5267	74	
Female	6137	89	
Onset type (*n*)			0.004
First onset	8632	131	
Recurrence	1195	32	
Age (month)	27.93 ± 17.94	24.79 ± 17.04	0.143

This study showed that female children and left arm involvement are predominant in RHS, which was essentially in accordance with the results of prior studies.[6] This finding was thought to be because the left arm was more chronically held by a caretaker's dominant right hand, and the development of muscle and ligament strength in the child's dominant right arm was faster, which may have preventive effects for the right arm.[7,8] It was unclear if female predominance was connected with anatomical factors or behaviors. Welch et al.[9] reported that there were gender-related differences in the care-taking behaviors between male and female. Young girls was more frequently held or picked up by hands when they fall down. In addition, Hansen et al.[10] found that estrogen may enhance the risk of injuries due to reduced fibril crosslinking and enhanced joint laxity in a sex hormones and tendon study; perhaps these results were more or less correlative between estrogen and RHS.

Numerous studies have reported that the most prevalent injury mechanism associated with RHS was pull (49%–61%).[1,2,11] In the study, the main injury mechanism was pull (90.57%, $n = 10, 339$), followed by fall (1.56%, $n = 178$), and hit (0.75%, $n = 86$); there were also unknown mechanisms (7.02%, $n = 801$). The specific causes of injury were various, but axial traction in the upper limb was the most common cause of pull, which often occurred when children were picked up, dressed or undressed by their guardians. Fall injuries commonly occurred when children started walking with a higher mean age. Turning over was one of the most common causes of hit injuries. Bilateral subluxation occurred mostly in the process of playing when children were held by both hands by their guardians. The less common causes including colliding with others or objects ($n = 8$), being injured by parents while sleeping ($n = 4$), and domestic violence ($n = 2$) in this study. It was noteworthy that almost all patients were repeatedly asked whether there were pull movements when injured, which is probably why the mechanism of pull was the most common and unknown was less. This question was likely due to the diagnosis training for emergency surgeons.

Manipulative reduction is the main treatment for RHS, which includes SF maneuvers and HP maneuvers.[4] Making a definite diagnosis of RHS and exclusion of fracture is the precondition that the healthcare provider proceed with reduction. Inquiring about the injury mechanism of the child in detail (including trauma, violence, pull, fall, etc.), and then checking the signs of swelling and deformity of the elbow, which were essential for initial diagnosis of RHS. For cases with suspected fracture or reduction failure, radiographs should be performed to eliminate the elbow fracture and to avoid further damage aggravated by unnecessary manipulative reduction.[12]

This study found that the success rate of manipulative reduction has slight differences among different levels of attending doctors; senior pediatric orthopedic surgeons have a higher success rate than emergency surgeons and junior pediatric orthopedic surgeons. Different doctors have different reduction choices, and the success rate of different reduction methods is different; most emergency physicians choose the SF maneuvers in this study, but a meta-analysis showed that HP had a higher success rate than SF.[13] However, senior pediatric orthopedic surgeons had more clinical experience and professional knowledge than others. In short, although professional training allows emergency physicians to cope with RHS, a referral to specialists is needed for those failed cases. In this study, 163 patients attempted self-reduction before they visited the emergency department, and 32 had a history of recurrence; these results show that the recurrent cases tended to be cases of attempted self-reduction ($p = 0.004$), which may be related to a loose annular ligament.

RHS had different incidence rates in different months, approximately two-thirds of RHS occurred in the first three months and the last three months during one year in the study, as shown in

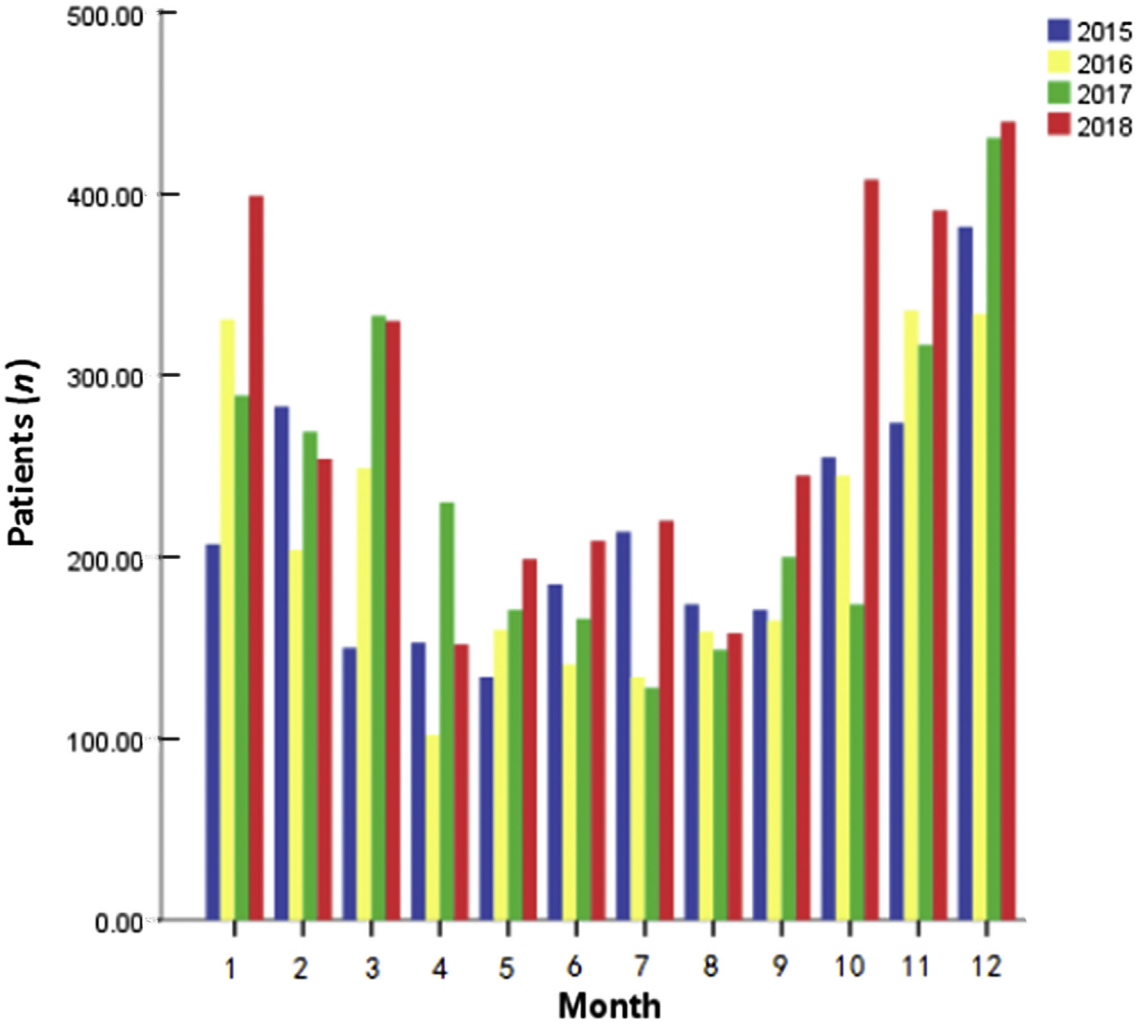

Fig. 3. The month of RHS onset among different years.

Fig. 3. To the best of our knowledge, in the northern hemisphere, temperatures are commonly lower from January to March and from October to December. Wearing the thicker clothes brings more opportunity to be pulled during taking clothes on and off. Due to the decrease of outdoor activities, children have more contact with their guardians in smaller interior spaces. These circumstances are more likely to lead to pull-related actions and increase the probability of RHS. It is possible reason that RHS occurred more frequently in the cold season.

Some children experienced recurrent episodes of RHS, likely related to the increased laxity in the annular ligament during childhood, but it is unlikely to occur after 7 years of age.[14,15] The reported recurrence rates of RHS were diverse in recent years, and most previous studies have reported a recurrence rate from 27% to 39%.[1,6,16] However, in this study, there are some differences in the incidence of recurrent RHS, about 12.16% (1195/9827) of patients had at least one previous episode of RHS, which is far lower than before and is closely related to our health education and prevention strategies for every patient's family. Among the recurrent cases, the most common frequency of recurrence was 1 or 2 times, and the highest recurrence rate was 5 times, the rate mainly depended on the guardians' attention and the children's daily behaviors. In addition, it seemed that male children with younger age had a higher rate of recurrence. Relevant studies reported that there is an increased risk of subluxation when subjected to axial traction in children younger than 5 years old.[7] In this study, the male recurrence rate was 10.85% (666/6137) compared with the female recurrence rate of 10.06% (530/5267), which was consistent with the results of previous studies. From our perspective, male children tend to be more active than female children and are more likely to fall and cause RHS-related injuries. But this study showed that there was no significant difference in the recurrence rates between different genders, which may be related to our health education for all the guardians of the patients, so that the parents paid more attention to daily baby care. Moreover, regarding the recurrence rates of RHS, we wondered whether the anatomical differences between the genders would increase gradually as the age increased.

RHS was a common injury in young children and easily recurrent between the ages of 10.73–44.53 months in this study, so it was extremely important to prevent it from happening. RHS is a preventable pediatric injury[4]; parents, teachers and other healthcare providers of this age group should be trained about the mechanism of this injury and should be told to watch out for some behaviors in daily life, such as avoiding pulling the forearm when children fall down or play, choosing loose and open-fitting clothes and dressing and undressing the affected limb first. Accordingly, prevention of RHS is particularly important to avoid treatment.

By virtue of the retrospective nature of the data and research, some data points are not suitable for analysis. The data we collected are based on the medical records of emergency physicians, so there

was possibly inevitable bias in the records. In addition, we did not have detailed statistics about the different manual reductions among the different physicians; the most common manual reduction method we chose was SF, but there were physicians who adopted HP in this study, especially in the cases that failed, and both methods were frequently used for resetting. Finally, for the recurrent cases, we may lose part of the data due to a subsequent visit in a different medical facility.

RHS is one of the most common upper extremity injuries in infants and young children. Although RHS reduction is easily performed and complication is rare, the injury sometimes recurs; in fact, it is still essential to refer failed cases to specialists, and the prevention of RHS is particularly important. Studying the characteristics of RHS, including the dominant roles' age, gender, season, and injury mechanisms, can help patients better prevent RHS and will provide more useful guidance for clinicians.

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None.

Ethical statement

Not applicable.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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