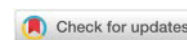


DISTAL RADIUS FRACTURES IN CHILDHOOD - OUR FIVE-YEAR EXPERIENCE

Rosen Staykov^{1*}, Nikolay Kolarov¹

¹Clinic of Orthopedics and Traumatology, St. Anna Multiprofile Hospital of Varna, Varna, Bulgaria

e-mail: Poseh_md@abv.bg; nikolai.kolarov@mu-varna.bg



Abstract: The most common fractures in children are those of the distal radius. There are relatively scanty publications devoted to this specific pathology in childhood. The timely diagnosis and proper treatment of the distal radius fractures are of undoubted significance. The purpose of the present communication is to share our recent practical experience with the management of the distal radius fractures in children. 2. Methodology. During the period between January 1, 2017 and December 31, 2021, 34 children at an average age of $10,85 \pm 3,00$ years (between two and 17) with wrist joint injuries resulting in distal radius fractures were examined in the Clinic of Orthopedics and Traumatology, St. Anna Multiprofile Hospital of Varna. There were 21 boys at an average age of $11,43 \pm 3,39$ years (between two and 17) and 13 girls at an average age of $9,92 \pm 2,38$ years (between six and 12). Diagnosis was based on clinical and x-ray examinations. Therapeutic behavior included operative treatment, administration of analgesic means, immobilization, and, in some cases, subsequent rehabilitation. Surgery was accomplished under general anaesthesia in most cases. 3. Results. Mean age did not differ statistically reliably between both groups ($t=1,524$; $p>0,05$). The left radius fractures (13 in boys and 11 in girls) were statistically significantly more common than right radius ones (eight in boys and two in girls) ($t=3,726$; $p<0,001$). Most commonly, a closed reduction technique with or without internal fixation of the radius and ulna was made use of (in 15 boys and in seven girls) followed by reposition and fixation with one Kirschner wire (in one girl), with two Kirschner wires (in five boys and one girl), or with three ones (in five boys and two girls). An open reduction technique was applied in six boys and in six girls followed by reposition and fixation with one Kirschner wire (in one girl), with two Kirschner wires (in two boys and two girls), or with three ones (in two boys). It should be noted that internal fixation was not carried out in two boys and three girls. Control x-ray examination was performed in all the children. Cast immobilization for a period between 28 and 35 days, most often, for one month, was obligatorily done. Subsequently, Kirschner wires were removed in eight boys and in four girls. One complication was observed in a six-year old girl. It was caused by mechanical damage of the left wrist joint following the implantation of the internal orthopedic devices, i.e. three Kirschner wires. They were removed two months after the operation. Complete healing was achieved in all the children. 4. Conclusions. Based on these results of ours, the conclusion can be drawn that these surgical procedures along with the precise diagnosis and immobilization have proven to be safe and effective in the children with distal radius fractures. Obviously, modern strategies to successfully prevent the fractures in children should be developed.

Keywords: *distal radius fractures, children, reduction techniques, internal fixation, Kirschner wires, cast immobilization*
Field: *Medical Sciences and Health*

INTRODUCTION

Distal radius fractures are most common in children. There are relatively scanty publications devoted to this specific pathology in childhood. The timely diagnosis and proper treatment of the distal radius fractures are of undoubted significance.

In boys, peak incidence rate of distal radius fractures is between 12 and 14 years and in girls, between 10 and 12 years (Corsino, Reeves, & Sieg, 2022). In an observational study during the period between 2002 and 2016, there are a total of 155891 children aged <18 years with distal radius fracture (Morohoshi et al, 2022). The sex specific and age standardized incidence rate is 531 per 100,000 patient years at risk (between 528 and 533 at 95% confidence interval). The risk for fracture is highest in summer and lowest in winter. There is a highest seasonal variation among boys aged two to five years.

The results from a population-based epidemiology cohort study in children aged up to 17 years during the period between 2013 and 2017 in Denmark demonstrate that the greenstick radius fracture is the most common distal forearm fracture (in 958 girls or in 22,20%, in 1109 boys or in 25,70% and in 2067 children or 47,90% of the cases) (Korup et al, 2022). The results from a retrospective epidemiological investigation in Shenzhen, China, during the period between July 2015 and February 2020 SHOW

*Corresponding author: Poseh_md@abv.bg



pediatric distal radius fractures in 1587 sites (Qiu et al, 2022). Predominantly, the school age group is affected (in 767 sites) followed by adolescence (in 489 sites), preschool age (in 291 sites) and infancy (in 40 sites). Most fractures occur in 2017 (424) while in 2019, there are 298 fractures.

The observational cohort study of the Swedish National Patient Register during the period 2005-2013 identifies 90970 pediatric distal radius fractures (Südow & Navarro, 2021). The average age at the time of fracture is ten years. In the age group between 10 and 17 years, there is a statistically significantly larger proportion of boys. Peak incidence rates are in May and September.

The purpose of the present communication is to share our recent practical experience with the management of the distal radius fractures in children.

MATERIALS AND METHODS

Between January 1, 2017 and December 31, 2021, children at an average age of $10,85 \pm 3,00$ years (between two and 17) with wrist joint injuries resulting in fractures of the distal radius part were examined in the Clinic of Orthopedics and Traumatology, St. Anna Multiprofile Hospital of Varna. There were 21 boys at an average age of $11,43 \pm 3,39$ years (between two and 17) and 13 girls at an average age of $9,92 \pm 2,38$ years (between six and 12). Diagnosis was based on clinical and x-ray examinations. Therapeutic behavior included operative treatment, administration of analgesic means, immobilization, and, in some cases, subsequent rehabilitation. Surgery was accomplished under general anaesthesia in most cases.

RESULTS

Mean age did not differ statistically reliably between both groups ($t=1,524$; $p>0,05$). The left radius fractures (13 in boys and 11 in girls) were statistically significantly more common than right radius ones (eight in boys and two in girls) ($t=3,726$; $p<0,001$). Some results of ours were illustrated in the following six figures.

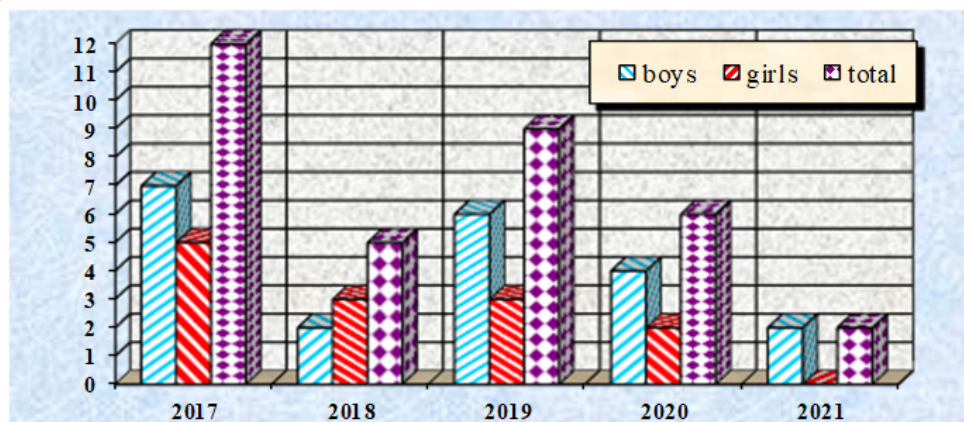


Figure 1. Annual dynamics of distal radius fractures

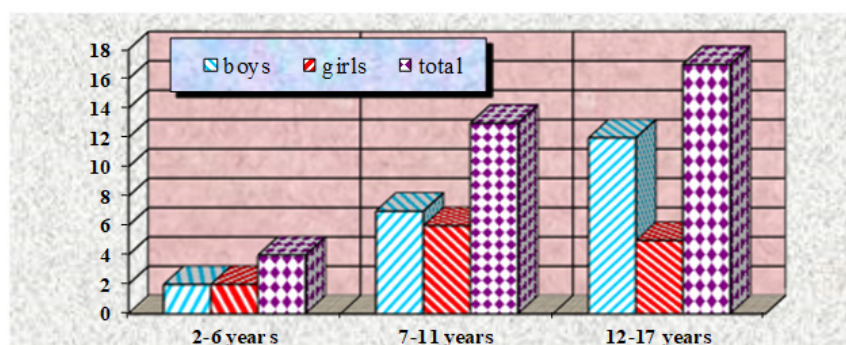


Figure 2. Age group distribution of distal radius fractures

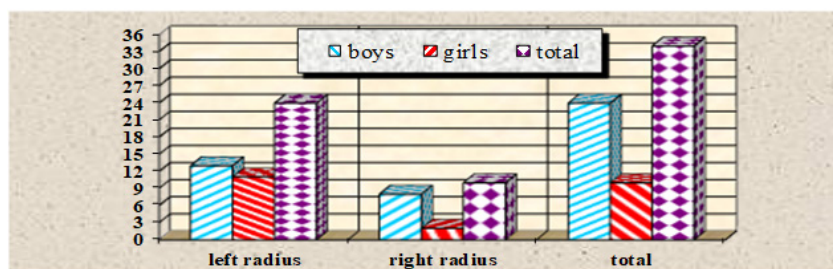


Figure 3. Localization of distal radius fractures

It should be noted that internal fixation was not carried out in two boys and three girls. Control x-ray examination was performed in all the children. Cast immobilization for a period between 28 and 35 days, most often, for one month, was obligatorily done. Subsequently, Kirschner wires were removed in eight boys and in four girls. One complication was observed in a six-year old girl. It was caused by mechanical damage of the left wrist joint following the implantation of the internal orthopedic devices, i.e. three Kirschner wires. They were removed two months after the operation. Complete healing was achieved in all the children.

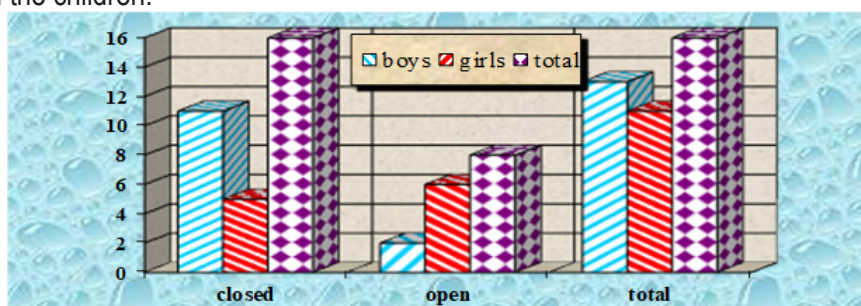


Figure 4. Reduction techniques in left distal radius fractures

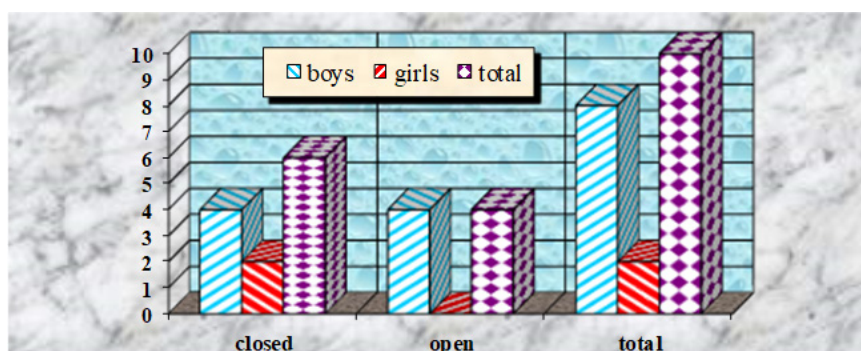


Figure 5. Reduction techniques in right distal radius fractures

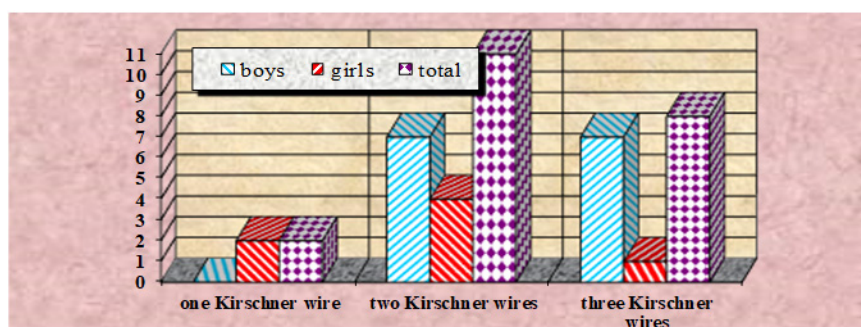


Figure 6. Kirschner wire usage in distal radius fractures

DISCUSSIONS

The treatment of choice of the fractures of the distal radius, one of the most common injuries in children, is a closed reduction followed by immobilisation in plaster cast while the immediate usage of osteosynthesis with Kirschner wires is reserved for single cases only (Persiani et al, 2022).

Among 34 boys and 22 girls under the age of ten years with a closed, completely displaced metaphyseal distal radial fracture, 16 are treated with a straight plaster cast and 40 ones with manipulation under anaesthesia, including 37 with Kirschner wire stabilization, between November 1, 2015 and January 1, 2020 in the United Kingdom (Marson et al, 2021). At discharge, all the children in the first group present with good range of motion. Five children are discharged at six to 12 weeks without any functional limitations at six-month follow-up. Eleven children are discharged between 12 and 50 weeks with a normal range of motion and radiologically proved remodelling. Redisplacement with angulation greater than 10° is observed in 17 children in the second group.

Within a retrospective study of 142 children with closed displaced distal metaphyseal radius fractures from January 2015 to May in China, initially, closed reduction is performed (Liu et al, 2021). Because of failed final reduction procedure, 21 patients are surgically treated. The incidence rates of failed and fair final reduction are statistically reliably higher in the overweight/obesity group than in the normal-weight one ($p=0,046$ and $p=0,041$, respectively). The risk factors related to redisplacement are overweight/obesity (odds ratio of 2,149; between 1,320 and 3,498 at 95% confidence interval), an associated ulnar fracture (odds ratio of 2,127; between 1,169 and 3,870 at 95% confidence interval), and a three-point index of $\geq 0,40$ (odds ratio of 3,272; between 1,975 and 5,421 at 95% confidence interval).

A completely displaced fracture of the distal metaphyseal radius in 12 children under ten years of age is immobilized leaving the fracture in an overriding position (shortening by 3 mm to 9 mm) while in 12 age-matched controls, a similar fracture is reduced and pin fixed at a 2,5-year minimal follow-up during a Finnish pilot study comparing reduction and no reduction (Laaksonen et al, 2021). No forearm deformity is observed. The maximal angulation in radiographs is 5°. In all the children, forearm and wrist movement is restored ($<10^\circ$ of discrepancy).

Among 26 children aged between 10 and 14 years and presenting with irreducible diaphyseal-metaphyseal junction fractures of the distal radius, both limited open reduction and transepiphyseal intramedullary fixation with Kirschner wire are used in 14 children while open reduction and internal fixation with plate and screw are applied in the rest 12 ones (Wang et al, 2022). In the first group, there is a statistically significantly shorter operation time (22,1 min versus 46,7 min; $p<0,0001$) and healing time (4,79 weeks versus 5,64 weeks; $p=0,03$) as well as a smaller surgical incision (2,43 cm versus 5,00 cm; $p<0,0001$) and a lower cost of internal fixation (US\$ 40,6 versus US\$ 2020; $p<0,0001$).

Within a retrospective multicentre study in Hungary during the period between January 2019 and January 2020 of 26 children aged between five and 12 years with severely displaced distal metaphyseal radial fractures, six patients are treated with biodegradable poly(L-lactide)-co-glycolide acid implants (Bioretec®, ActivaPin®), while 13 children are treated with one or two stainless steel Kirschner-wires (Sanatmetal®) buried under the skin and seven ones are managed with Kirschner-wires left outside the skin (Varga et al, 2022). In the first group, the complication rate is statistically significantly lower and no second surgical intervention is required.

In 112 children aged up to 16 years, 113 completely displaced overriding metaphyseal fractures of the distal radial are treated during the period between 2014 and 2019 in Finland representing an average annual incidence of 1,42 per 10000 population (between 0,72 and 2,01 per 10000 population) (Laaksonen et al, 2022). Closed manipulation is attempted in 75 cases in the emergency department, with a failure rate of 46% while strong opioids are administered in 70 patients. On the Likert scale, the mean satisfaction with treatment is 6,2.

In a prospective, randomized controlled trial of 59 children at an average age of 9,9 years (between four and 16 years) with isolated distal radius fractures, 31 children are treated with short-arm fiberglass cast and 28 ones with long-arm cast after closed reduction in Switzerland (Seiler et al., 2021). No statistically reliable differences between both groups either in loss of reduction, nor in analgesic therapy duration are established.

The benefits of using the minimally invasive surgical treatment of closed reduction using Sommer - pins with Kapandji technique in 48 completely dislocated fractures of the distal radius after ineffective non-surgical treatment of children aged six to 14 years during the period between 2012 and 2017 are evaluated (Kamiloski et al., 2018). The anatomic reduction is easily achieved with this technique in every case. The postoperative immobilization lasts four to seven weeks with an underarm cast. During a six-month follow up, there is no significant loss of reduction and need for another surgical procedure.

3D-printed patient-specific casts obtained with specifically designed software using scanning device are safe in the management of 'buckle' fractures of the distal radius in ten children treated in an Academic level I pediatric trauma centre in Italy (Lazzeri et al, 2022).

In 189 children under 16 years of age with displaced distal radius fractures undergoing conservative treatment, there are statistically significant differences between normal weight and obese patients in terms of the number of the loss of reduction ($p=0,002$), severity of initial translation ($p=0,008$) and quality of initial reduction ($p=0,01$) (Vescio et al, 2022). Among 176 children with fractures of the distal radius treated in the Emergency Department of the Bahrain Defense Force Hospital during a retrospective cohort study from January 1, 2015, to February 1, 2022, 77 patients are conservatively managed with cast immobilization while 99 are surgically managed - 56 with percutaneous pinning or 43 flexinail (Aladraj et al, 2022). There are statistically reliable differences in radial inclination between conservative and percutaneous pinning ($22,22\pm2,860$ versus $18,76\pm3,330$) ($p<0,001$) and between percutaneous pinning and flexinail ($18,76\pm3,330$ versus $22,37\pm3,440$). There are 19 complications in the conservative group, five in the percutaneous pinning and one in the flexinail group ($p=0,003$).

Between 2012 and 2015, 26 children aged under 17 years undergo closed manipulation and cast immobilization under general anaesthesia for a fracture for the distal third radius (Constantino et al, 2021). Redisplacement is observed in four children. Quality of reduction is a statistically significant risk factor for this redisplacement ($p=0,013$).

Between February 2017 and December 2018, a long arm cast without reduction, analgesia, or sedation is applied in 11 children with closed overriding fractures of the distal radius in Italy (Marinelli et al, 2021). The mean initial radial shortening is of 5 ± 3 mm and the mean initial sagittal and coronal angulations are of $4,0^\circ$ and $3,5^\circ$, respectively. Mean duration of casting is 40 days. The procedure is by seven times less expensive than closed reduction in emergency room under sedation and a long arm cast usage as well as by 64 times cheaper than closed reduction in the operating room under anaesthesia, percutaneous pinning, and a long arm cast application.

A loss of reduction is reported in 102 of 360 children with distal metaphyseal radius fractures (Persiani et al, 2022). Of them, 51 undergo an additional reduction procedure. In the rest 51 cases, reduction loss is acceptable in respect to the expectation of remodelling. Plaster cast quality is of importance for reduction maintenance. A severe primary displacement is the most statistically reliable variable for the secondary displacement occurrence.

Within a retrospective population-based cohort study between 2003 and 2015, 70801 low-risk fractures of the distal radius in children are treated in emergency departments in Ontario, Canada (Baxter, To, Chiu, Camp, & Howard, 2021). Boys are 2-14 years old and girls are 2-12 years old. There is no physician follow-up in 14742 fractures (in 20,82% of the cases). Management in a small hospital emergency department (risk ratio of 1,86; between 1,72 and 2,01 at 95% confidence interval), treatment by a pediatrician (risk ratio of 1,22; between 1,11 and 1,341 at 95% confidence interval), or treatment by a subspecialty pediatric emergency medicine-trained physician (risk ratio of 1,73; between 1,56 and 1,92 at 95% confidence interval) result most likely in no follow-up. The results from a prospective clinical study of 50 five to 15 year-old children with isolated fractures of the distal radius in Istanbul, Turkey, indicate statistically significantly lower 25-hydroxyvitamin D serum levels ($p<0,001$) and a incidence of 25-hydroxyvitamin D insufficiency ($p=0,012$) than in 50 healthy children (Talmac et al, 2021).

CONCLUSIONS

Based on these results of ours, the conclusion can be drawn that these surgical procedures along with the precise diagnosis and immobilization have proven to be safe and effective in the children with distal radius fractures. Obviously, modern strategies to successfully prevent the fractures in children should be developed.

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