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Original Article

Evaluation of Clinical and Radiological Outcomes after Cross Pinning and Transverse Pinning Methods in Metaphysis Distal Radius Fractures in Children

Ali Mousapour[1], Mohammad Reza Anvar[1], Maziar Malekzade[1] and Ghobad Ramezani[2]*

1. Department of Orthopedic and Trauma surgery, Taleghani Hospital, School of Medicine, Kermanshah University of Medical Sciences, Kermanshah, Iran
2. Education Development Center, Kermanshah University of Medical sciences, Kermanshah, Iran

Abstract

Background: Distal radius fractures are among the most common and important fractures in children. Among surgical techniques, percutaneous pinning is a widely used and relatively simple method for treatment. This study aims to compare the outcomes of parallel versus transverse pinning in such fractures.

Methods: In this cross-sectional study, children aged 5 to 10 years with distal radius fractures who were referred to Ayatollah Taleghani Hospital during 2021–2022 were included. After taking a detailed history and performing clinical examination, patients were treated using either parallel or transverse pinning techniques.

Results: A total of 47 patients were evaluated, including 35 boys (74.5%) and 12 girls (25.5%) with a mean age of 7.5±1.7 years. In both surgical groups, the DASH and MAYO scores showed significant improvement compared to preoperative status. This reflects improved function, reduced symptoms and pain, higher patient satisfaction, and better hand performance. However, no statistically significant difference was found between the two groups in postoperative DASH and MAYO scores.

Conclusion: The results indicate that both parallel and transverse pinning methods yield similar clinical outcomes and complication rates. Therefore, either technique can be considered safe and effective for managing distal radius fractures in children.

Keywords: Bone, Fractures, Men, Patient satisfaction, Radius

*** Corresponding author**

Ghobad Ramezani, PhD
Education Development Center, Kermanshah University of Medical sciences, Kermanshah, Iran
Tel: +98 9187804553
Email: ramazanighobad@gmail.com

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Introduction

One of the most common types of fractures in orthopedic clinics is distal radius fracture. This type of fracture in younger people often occurs after major trauma while in elderly people, it is more often observed after minor injuries. Since these types of fractures result from a wide variety of injury patterns in the wrist, treating them can be a challenge for orthopedic surgeons.

Distal radius fractures are common injuries in children. Approximately 40-50% of all boys and 30-40% of girls suffer from at least one fracture in childhood (1,2). The rate of fractures is more common in boys and this increase is probably related to their high activity compared to girls (2). In fact, forearm fracture constitutes 40% of all fractures in children, and fracture of the end of the radius bone is considered one of the most common and important fractures in children and young age groups (3-5). Evidence from Scandinavian countries, Europe, Japan and the United States show that the rate of fracture of the end of the radius in children is increasing (6-8). In some studies, an increase in the rate of surgical intervention has also been reported (9,10). Fractures at the end of the radius in children have excellent healing and reconstruction capabilities due to skeletal immaturity (11).

Majority of the complications related to radius fractures occur in unstable fractures. Unstable fractures include comminuted fracture with longitudinal angulation of 25 degrees or more, radial bone shortening of more than one centimeter, and significant comminution with intra-articular fragments (12). The treatment of radius end fractures has changed a lot over time. Pinning through the skin to create stability is one of the first methods of internal stabilization. This is a low-cost and minimally invasive technique that can be used to treat extra-articular fractures and simple intra-articular cases (13). Other treatment methods, including the use of external fixators and various plaques, and using of bone and cement grafts, and finally, arthroscopic methods have been used to replace the joint surface (14). With the advancement of these techniques, it is possible to provide the patient with a better performance and a faster return to daily life. The purpose of this study is to investigate the difference between two methods of cross pinning and transverse pinning in fractures of the end of the radius bone in children.

Materials and Methods

This research is a cross-sectional study. The study population constituted children who were referred to Ayatollah Taleghani Hospital in 2021-2022 due to a fracture of the end of the radius bone. The sample size was calculated based on the following formula with an alpha of 0.05 and a power of 95%, based on the study of Sengab *et al* (15). The final volume of the sample was 47 samples, taking into account a drop of 20%.

Data collection method

Patients in the age group of 5 to 10 years were included in the study. At first, patients with physeal fracture or simultaneous ulna bone fracture and fracture with erosion were subjected to detailed history and clinical examination, they were excluded from the study and only patients with fracture with metaphyseal displacement were evaluated. In this study, the patients underwent surgery under sterile conditions and after placing the package under fluoroscopic guidance without skin incision by two methods of cross pinning and transverse pinning. Radiographs with anterior-posterior and lateral views were taken from all the patients (Figure 1). Patients were randomly divided into based on the type of fracture.

In the cross-pinning method, two pins are crossed without passing through the ulna bone, and in the transverse pinning, fixation is done transversely and with complete passage of 4 pins on both sides of the fracture site, and the pins pass completely through the radius and ulna bone had been done. After pinning, a control radiograph was performed, and if acceptable criteria were obtained, Sugartongue splint fixation was taken, and after one month, a control radiograph was taken to ensure the union, and then the pins were removed and the wrist movements were examined. And scoring was done based on dash score and Mayo score criteria. Clinical examinations included information about the ability to perform daily activities, wrist ability and range of motion. The intensity of pain in each visit was measured using the patient's pain score. Daily activities were classified

in three levels (completely as before, relatively as before and reduced). In this system, the amount of pain, range of motion relative to the healthy side, functional status, wrist deviation and hand punching strength were evaluated by a physiotherapist using a dynamometer. Data were recorded based on Mayo score and dash score questionnaires, and after completion, the information was entered into SPSS software and subjected to final analysis. Patients with simple metaphysis were included in the study. Patients with physeal or wear or simultaneous fracture of the ulna were excluded from the study.

Data analysis

After collecting the data, it was entered into SPSS software version 22. Data analysis was performed using chi-square statistical tests for the qualitative variables and paired T-test for the quantitative variables, and the significance level of p=0.05 was considered. Also, the results of the normality test showed that the data has a normal distribution (Sig= 0.211). Descriptive results are presented as number, percent. mean and SD.

Results

In the current study, 47 patients with a fracture of the distal end of the radius underwent surgery with two transverse and transverse methods. In this study, 35 boys (74.4%) and 12 girls (25.6%) with an average age of 5.7±7.1 years, with an average DASH Score of 0.87±1.6. The participants had an average MAYO score of 5.4±3.97, as shown in table 1.

In table 1, the process of changes one month after the operation and six months after the operation was examined. In both surgical groups, DASH Score and MAYO Score variables were significantly different compared to one month after surgery. This significant difference means improved function and symptoms, improved pain, patient satisfaction and punching ability in the patients.According to the results of the above table, there was no statistically significant difference between the ages in the two groups. But there was a statistically significant difference between gender in the two groups under study. In both surgical groups, there was no statistically significant difference in DASH Score and MAYO Score six months after surgery which shows that the improvement process of function and symptoms, improvement of pain, patient satisfaction and the ability to punch and grab are the same in patients of both groups. In this study, 97% of patients' right hand was involved. Also, there was 1 case of pin site infection in the cross-surgery method and 2 cases of delayed fusion in the transverse surgery group, where the pin was kept for two more weeks for treatment.

Table 1. Demographic characteristics of the studied patients in general using descriptive statistics

Variable	Mean	SD
Age	7.5	1.7
DASH score	0.87	1.6
MAYO score	97.3	4.5
Female (frequency percentage)	12(25.6%)	-
Male (frequency percentage)	35(74.4%)	-

According to Chart 1 and figure 2, the cross-surgery method has the highest percentage at the ages of 5, 6, 8, and 9 years, which was 80, 63.64, 66.67, and 85.5%, respectively. However, at the ages of 7 and 10 years, the transverse surgery method was the most frequent, which was 62.5 and 55.56%, respectively.

The DASH questionnaire examines the symptoms and performance of patients, and the range of these scores ranges from 0 without disability to 100 complete disabilities. According to the Chart 2, the range of zero score is 21 patients, 61.76% in the crossover group, and 13 patients, 24.38% in the crossover group, are without disability. In the range of 2.3, 5 patients (55.56%) in the cross-sectional group and 4 patients (44.44%) in the transverse group had very mild disability that improved after follow-up.

In Chart 3, the pain score, satisfaction and grasping ability of the patient based on the Mayo scale were investigated. The range of scores obtained in this study is from good to very good (80-89 good; 90-100 very good). At the level of a good grade, the crossover method with 3 patients is 100%, at the level of a very good grade; the score of 90 cross-sectional methods with three patients was 75%, and at the level of score 95, both methods were equal to 4 patients and 50%, and at the level of score of 100, the cross-sectional method with 21 patients had the highest satisfaction rate of 65.63% (Figure 3).

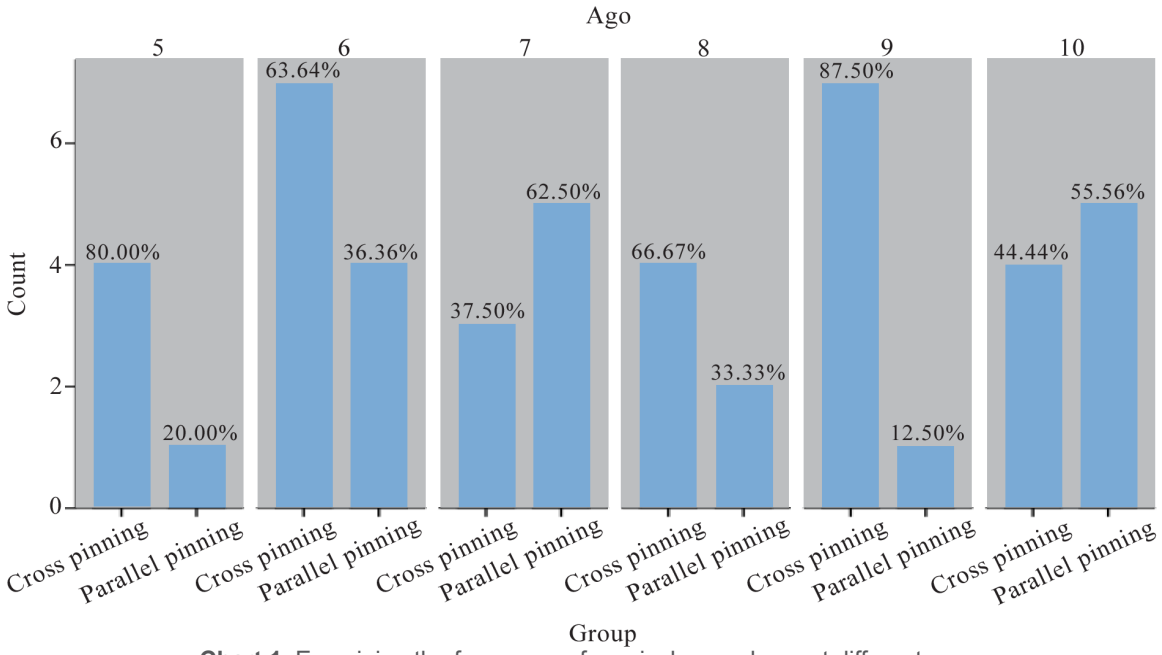

Chart 1. Examining the frequency of surgical procedures at different ages.

Table 2. Comparison of changes in variables in two groups before and after surgery

Variable		1 month after the operation	6 months after the operation	p-value
Cross-surgical method group	DASH score	7.6±1.6	0.94±1.7	0.001
	MAYO score	60.1±3.7	97.4±4.9	0.001
Transverse surgical method group	DASH score	4.1±1.8	3.1±0.76	0.001
	MAYO score	61.1±3.7	97.2±2.97	0.001

Significance level 0.05; the statistical test performed is paired t-test.

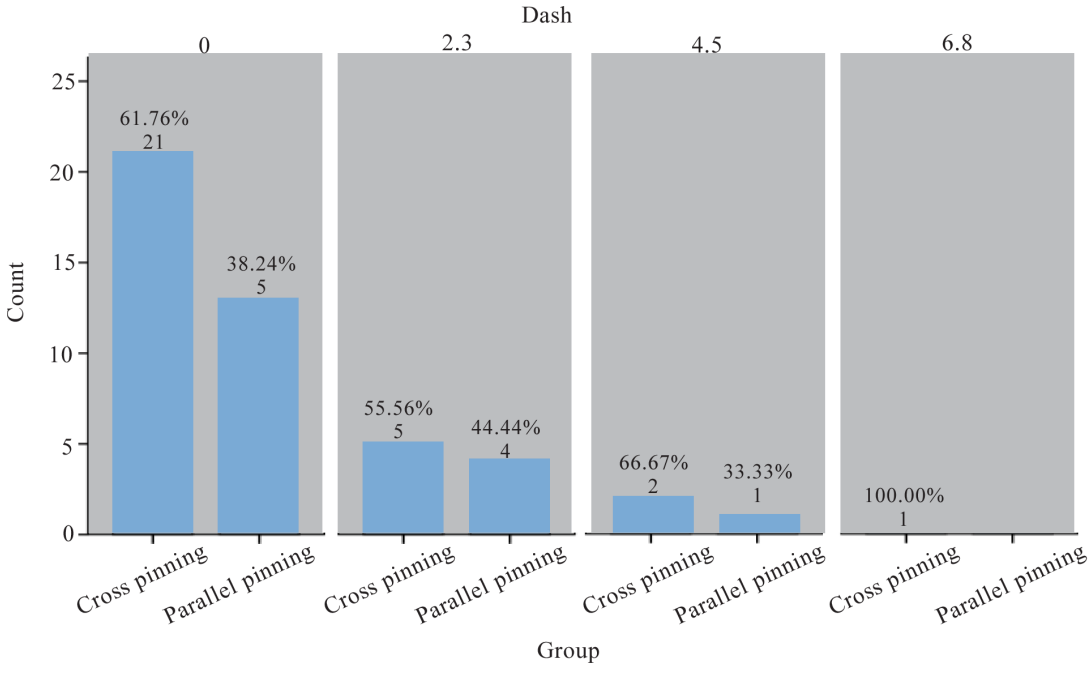

Chart 2. Examining the scores obtained from the DASH questionnaire.

Table 3. Review of the demographic and clinical characteristics (after surgery) based on the groups under study

Variable		Cross-surgical method group Mean±SD	Transverse surgical method group Mean±SD	p-value
DASH score		1.7±0.94	3.1±0.76	0.071
MAYO score		9.4±4.97	9.3±2. 97	0.089
Age		7.5±1.7	7.7±1.7	0.080
Gender	Female	9(0.31)	3(0.17)	0.004
	Male	20(0.69)	15(0.83)	

Significance level 0.05; the statistical test performed is the independent t-test.

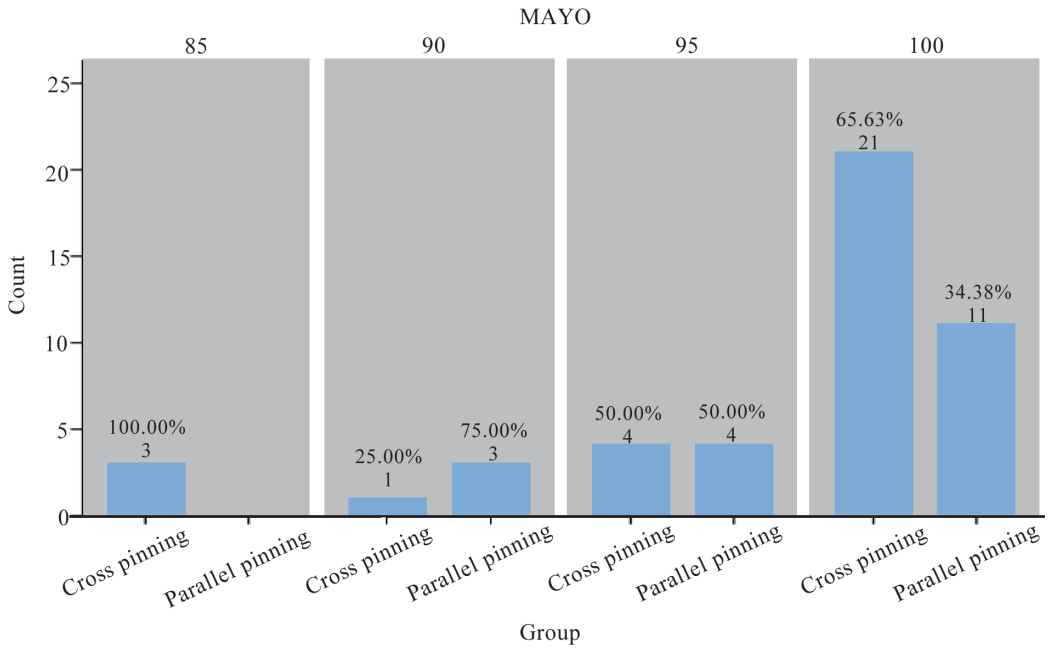

Chart 3. Examining the scores obtained from the MAYO questionnaire

Figure 1. Schematic representation of the two surgical techniques used in the study: (A) Parallel pinning and (B) Transverse pinning for distal radius fractures in children.

Figure 2. Comparison of postoperative outcomes using DASH and MAYO scores between the two groups. Both techniques showed significant improvements, with no statistically significant difference between them.

Figure 3. Distribution of participants by age group and gender across both surgical methods. No significant differences were observed between the groups.

Discussion

Considering that the fracture of the distal radius is one of the most common fractures, it requires a suitable treatment method to achieve the desired result, since inappropriate and insufficient treatment in reducing and maintaining will cause disruption in the daily functioning and efficiency of the person (8). This study was conducted with the aim of investigating the clinical results of the cross-pinning and transverse radio-ulnar pinning methods in unstable fractures of the distal radius in children. The results demonstrated that there was no significant difference between the clinical results of the two groups. It seems that the two methods of pinning in this type of unstable distal radius fractures do not differ from each other. This lack of difference was also true regarding the amount of pain, the presence of complications, and having limited mobility.

Gradl *et al* found in a study that the two methods of intramedullary nail and volar plate fixation do not differ from each other in terms of radiological and functional factors (9). Li-hai *et al* reported in a meta-analysis study that the two methods of volar locking plate and external fixation are similar in terms of side effects and patient performance (10). However, in the study of Handol *et al*, it was reported that the two methods of percutaneous pinning and Kapandji pinning cannot replace each other in unstable fractures of the distal radius (11). In a study, Stein *et al* also examined plastering and external fixation in distal radius fractures. They reported that the conditions of using these two methods are different; as a result, the radiological and functional findings of the patients will be different from each other (12). These findings are consistent with the current study.

The reason for this difference can be the difference in the type of patient selection and the type of surgical procedure. Therefore, the age of the patient and the quality of the bone, the type and shape of the fracture, the mechanism and the severity of the injury play a decisive role in the patient's recovery. Obtaining acceptable initial extension by closed traction and reduction in distal radius fractures is not difficult, but maintaining it is difficult. Of course, in the treatment of the patient, the condition of the soft tissue, the way of life and accompanying diseases should also be considered. The most important factors that are effective in treatment results are first the radial length and then the velar rotation (13).

The average age of the studied patients in both groups was not significantly different, and these results were consistent with the study of Suleimanpour *et al* (14). Distal radius fracture is the most common upper extremity fracture seen in all age groups which occurs in middle-aged and elderly people due to falling with open hands, and most patients also have osteoporosis, but it happens in young people due to strong force caused by falling from a height or in driving accidents. In this study, according to the average age of the patients, it was 7.7 years; most of them suffered from fractures due to falling from a height or tripping while playing or exercising, and a few suffered fractures due to accidents.

The incidence of pain in the two groups was completely the same, and Nash *et al* found in a study that there was no difference between the pinning methods in terms of pain, swelling, and stiffness, which was consistent with the present study (16). McQueen *et al* suggested that proper reduction leads to better results in daily activities, fist strength, wrist range of motion and pain level (17).

No significant relationship was observed regarding the incidence of complications in both groups. According to this result, two treatment methods are equally safe. Complications were only 1 case of infection of the pin site and 2 cases of delay in welding, which required 2 more weeks for complete recovery. In terms of

clinical criteria, wrist movement limitation is also considered as a complication, but this condition was not present in the study. The use of physical exercises significantly improves the performance of patients in terms of hand and wrist movements. Performing physical therapy after removing the cast or fixator is useful for obtaining the ideal range of motion of the joint, resulting in faster recovery and a better prognosis. The severity of anatomical damage at the time of injury and the amount of residual deformation after treatment are effective in outcomes, especially punching strength and range of motion.

Conclusion

Based on the results of this study, the cross-pinning and transverse pinning methods have no statistically significant differences in terms of clinical criteria and surgical complications, and both methods had completely similar results and safety. It is suggested that in future studies, influencing variables such as the ability to return to daily activities in two groups should be investigated in a longer period.

Study limitations

One of the limitations of the study is the lack of investigation of influential variables such as doing physical exercises and physiotherapy. It is suggested to conduct a long-term study by examining the ability to return to daily activities in two groups.

Ethical considerations

This study was approved by the Ethics Committee of Kermanshah University of Medical Sciences (IR.KUMS.REC.1402.111).

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Conflict of Interest

The authors declare that they have no competing interests.

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