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# *Clinical Research Progress of Small Splint External Fixation in the Treatment of Distal Radius Fractures*

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***Abstract:*** Distal radius fractures are a common type of fracture disease in clinical practice. In recent years, they have become a frequently occurring fracture disease of the upper limb, accounting for approximately 5% of all fractures in the body and about 10% of all upper limb fractures [1]. With the development of society and the continuous improvement of people's living standards, the impact of fractures on People's Daily work and life is increasing day by day. The early recovery of functions and the reduction of trauma after fractures have also become the focus of everyone's attention. So finding a more convenient, efficient and economical treatment method has also become the ultimate goal. In our traditional Chinese medicine, the small splints used in orthopedic treatment for external fixation of fractures are the key treatment directions [2]. The small splint is one of the widely used orthopedic treatment techniques in folk medicine. It can play a positive therapeutic role in fractures or soft tissue injuries, and has a certain role in maintaining alignment and reduction.

## 1. External fixation with a small splint for the treatment of distal radius fractures

A distal radius fracture refers to a fracture within 3cm of the articular surface at the lower end of the radius. This area is precisely the force-bearing point in terms of anatomical position, a weak point, and also located at the junction of cancellous and compact bones. After being impacted by an external force, the force acts on this area, making it very easy to form a fracture. This is more common among the elderly, especially when they have difficulty moving around and are prone to osteoporosis. Under such circumstances, it is very easy for them to fall while walking, causing the palm base to hit the ground and resulting in fractures under stress [3]. And our wrist joint is in a zone of frequent movement, so there are very high requirements for functional recovery after a fracture. The functions of the wrist joint include wrist extension, wrist flexion, radial tilt and ulnar tilt, as shown in Figures 1-4 below. Young people may have higher requirements for anatomical reduction, while for the elderly, the requirements for functional reduction are far greater than those

for anatomical reduction. Compared with invasive surgery or open wounds, non-invasive reduction and the use of small splints to restore function is also a better option for elderly patients [4].

Wrist joint function diagram:

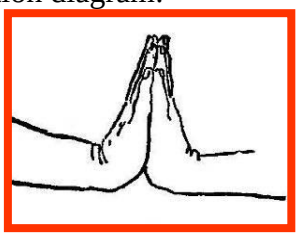

Figure 1: Stretch out the wrist

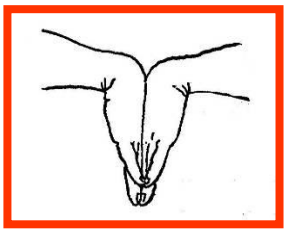

Figure 2: Wrist flexed

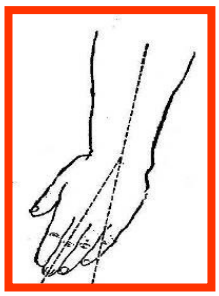

Figure 3: Radial tilt

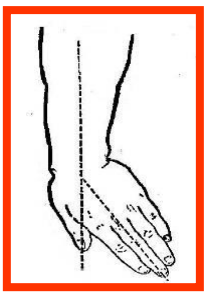

Figure 4: Ulnar tilt

Ye Wei et al. treated 92 elderly patients by applying the Southern Shaolin bone-setting technique [5]. They used the Southern Shaolin bone-setting technique to reduce the fractures of the patients, and then fixed them with small splints, making adjustments at any time. They observed the reduction of the technique and the short-term recovery of the fractures through X-ray films three months before and after the treatment. Eventually, a total of 88 cases had good or better recovery of wrist joint function. The excellent and good rate is 95%. It indicates that manual reduction combined with small splint fixation has a very good therapeutic effect on the functional recovery of patients with distal radius fractures. Compared with Western medical surgical treatment, it has the advantages of simplicity, convenience, non-invactionability and low cost.Wenbo Chen et al. treated 98 patients with fractures using small splints combined with Hongbai Shujin Powder [6]. Through the treatment, the fractures of all 98 patients healed, and the wrist joint function recovered and serum biochemical indicators such as tumor necrosis factor -α level, C-reactive protein, interleukin-6, etc. all improved. Yang Get al. observed the TCM syndrome scores of 60 fracture patients undergoing conservative treatment at 2, 4, and 6 weeks during the treatment period, the callus healing lines under X-ray films, and the recovery of wrist joint function [7]. They found that small splint fixation could effectively promote fracture healing, alleviate wrist joint pain and swelling in patients during conservative treatment, improve wrist joint function, and had good safety. Li Teng[7] et al. treated distal radius fractures with the combined eight-direction bone setting technique and small splint [8]. They treated 78 patients and followed them up for 4 weeks. Among them, 65 patients had good or better results. They demonstrated the superiority of the small splint in improving the Cooney wrist joint score, shortening the fracture healing time and reducing complications. Moreover, the combination of small splints and manual therapy can effectively restore the function of the wrist joint and fully improve the living conditions and quality of life of patients. Zhang Haiping [8]et al. treated non-comminuted Colles fractures with manual reduction combined with small splints. A total of 102 cases were included [9]. The therapeutic effects of the control group and the experimental group, the pain of the fractured limb, the condition of skin swelling and congestion, the recovery of wrist joint function, the callus score of X-ray, serum biochemical indicators, etc. all improved significantly after treatment. Moreover, the healing time of

fractures was further reduced. This literature speculates that this might be related to the increased levels of serum PGC-1α and CTRP3. Among the treatment outcomes, there were 39 patients with an excellent score, 54 patients with a good score, and 9 patients with a poor score. The excellent and good rate accounted for 91% of the total number of patients. Taichung Hui et al. observed the effect of Kirschler needles and small splints external fixation on the quality of fracture healing [10]. A total of 64 patients were included and equally divided into the control group and the experimental group according to the random number table method. Among them, the experimental group used Kirschler needles for internal fixation, while the control group used small splints for non-invasive external fixation. The research has proved that although the palmar inclination Angle and ulnar deviation Angle of the fracture site are more in line with anatomical alignment after fixation with the Krexler needle, in terms of the quality of life of patients, secondary trauma, postoperative healing, and the probability of complications, the control group is superior to the experimental group. Shen Yi et al. treated extended distal radius fractures with manual therapy combined with small splints and oral administration of traditional Chinese medicine [11]. A total of 60 cases were included, among which 22 cases were excellent, 29 cases were good, and 51 cases were excellent. The excellent and good rate was 85%. It was proved that manual therapy combined with small splints significantly shortened the healing time of fractures and the time for swelling to subside. Nie Lei et al. treated acute distal radius fractures with traditional Chinese medicine combined with small splints. A total of 120 cases were included [12]. The final treatment results showed that 65 cases healed, 42 cases were effective, 13 cases were ineffective, and 107 cases showed significant improvement, with a significant improvement rate of 89%. Yang Dejian et al.treated fractures with traditional Chinese medicine manual reduction combined with small splint fixation [13]. A total of 56 cases were included. Among them, 21 cases showed significant improvement, 27 cases were effective, 8 cases were ineffective, 48 cases showed significant improvement, and the improvement rate was 86%. Wei Jun et al. treated fractures with manual reduction of small splints. A total of 100 cases were included, and the follow-up period was 4 weeks [14]. Among them, 66 cases were excellent, 18 cases were good, 10 cases were fair, 6 cases were poor, and 84 cases were excellent. The excellent and good rate was 84%. Zhou Chao et al. treated patients with distal radius fractures by observing external fixation stent combined with Kirschner's needle fixation and control small splint fixation [15]. A total of 42 cases were included and divided into the control group and the observation group according to the differences in treatment methods. The treatment method of the observation group was small splint external fixation, and that of the control group was external fixation stent combined with Kirschner's needle fixation. The functional recovery rate was observed. Among them, in the observation group, there were 12 excellent cases, 8 good cases, 8 medium cases, 0 poor cases, and the number of excellent cases was 20, with an excellent and good rate of 95%. In the control group, there were 7 excellent cases, 8 good cases, 5 medium cases, 1 poor case, and the number of excellent cases was 15, with an excellent and good rate of 71%. This indicates that the small splint is more effective in the functional recovery of fracture patients.

Common complications: Common complications of small splint fixation include compression ulcers, ischemic muscle contracture, fascial compartment syndrome, and nerve palsy. These adverse complications are basically some adverse reactions caused by the improper tightness of the splint fixation. Among the 56 elderly patients with distal radius fractures admitted by Huo Jinsheng et al. 5 cases developed tension blisters [16]. After symptomatic treatments such as adjusting the tightness of the splint and changing the dressing at the affected area, all adverse reactions improved, and no other serious complications were recorded.Among the 80 patients treated by Yan Wenjie et al. there were 2 cases of diarrhea and abdominal pain, 2 cases of dizziness and nausea, 2 cases of loss of appetite, and 1 case of rash and itching [17]. A total of 7 adverse events occurred. The treatment measures were manual reduction combined with small splints and oral administration of traditional

Chinese medicine decoctions. The traditional Chinese medicine decoctions contained some drugs that could break blood stasis, remove blood stasis, guide blood downward, and promote blood circulation and unblock meridians. Therefore, adverse reactions may be more related to oral traditional Chinese medicine decoctions.

## 2. Modified small splint external fixation treatment

Small splint treatment has many advantages that surgical open reduction and internal fixation cannot compare with in clinical practice. However, to some extent, it also has many adverse side effects. Therefore, with the development of society, the technology of making small splints is constantly improving, including but not limited to the materials used to make small splints, the styles of making small splints, and the application methods. Chen Yangcong et al. improved the manufacturing method by using a small splint with an inflatable adjustable pressure pad for external fixation [18]. The tightness of the small splint can be judged at any time through X-rays, the degree of swelling of the affected limb, and the patient's own feelings. The tightness, position, size, and thickness of the pressure pad can be adjusted through the inflatable adjustable pressure pad. This enables patients to achieve better functional recovery and improve their quality of life. Moreover, when tension blisters occur, symptomatic treatment can be provided more promptly without affecting the original small splint treatment. The inflatable adjustable pressure pad can be flexibly adjusted according to the growth of callus at the fracture end, and provide more continuous, stable and uniform pressure to maintain the stability of the splint. At the same time, to a certain extent, it can also avoid excessive compression on the soft tissues around the fracture site to reduce the occurrence of related complications. Ren Baoliang et al. have improved the small splint treatment method with 3D technology [19]. It can simulate and print the fracture ends through CT scans and other means, and perform manual reduction and needle insertion fixation at the fracture ends. This can increase the relative stability of external fixation. Moreover, the holes on the small splint can make the skin more breathable and allow the blood of the tissue to flow back smoothly. The 3D-printed small splint adopts a porous structure, which can effectively reduce the compression of the small splint on tissues and blood vessels, increase venous reflux, and through in vitro 3D modeling, it can significantly shorten the operation time, improve the reduction accuracy, and enable doctors to observe and handle the fracture ends more intuitively before surgical incision. It can reduce medical costs to a certain extent. Ruanbett helps achieve more accurate therapeutic effects and alleviate patients' pain through visual algorithms for external fixation of small splints, as well as shorten the treatment time [20]. By using the method of digital images and combining with Phython's algorithm, more specific pressure values can be obtained through the pixel gray value. When compared with visual observation, this can be more scientific and rigorous, and a more scientific plan can be made for the tightness of the small splint, the wearing Angle, and the position of the strap.

## 3. Summary

For the current treatment plan of treating distal radius fractures with small splints, there is no common gold standard. It is more based on the current morphology of the fracture, the injury mechanism, and the patient's age and needs. The most important thing is to follow the clinical experience of the attending physician for treatment, which often has an impact on the treatment and postoperative recovery. With the development of society, the continuous progress of fracture treatment plans, the renewal of internal and external fixation materials, and the changes in internal and external medications, more patients choose surgical treatment. To a certain extent, although surgical treatment has many advantages, there are many adverse complications after the operation,

which may cause some irreversible damage to the body. Therefore, treatment methods should be carefully selected and personalized designs should be carried out to improve the clinical effect. Clinically, no matter which treatment is chosen for fracture patients, the ultimate goal is to restore the wrist joint function and physiological structure of the patients, promote functional recovery, and reduce the incidence of adverse complications. However, at present, there is still no clear treatment method with outstanding advantages. Different methods respectively have their indications and adverse complications [21].

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