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Scriptwriter Name: Vipasha Sharma

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Title: A Step-by-Step Protocol for Manual Reduction and Splint Immobilization of Distal Radius Fractures

Authors and Affiliations:

Zekai Qv^{1,2*}, Zhixian Gong^{2*}, Yantao Guo², Zhiming Tang², Xuyi Tan³, Gaoyan Kuang¹, Shaofeng Yang², Min Lu²

¹Hunan University of Chinese Medicine

²The First Hospital of Hunan University of Chinese Medicine

³Hunan Integrated Traditional Chinese and Western Medicine Hospital

*These authors contributed equally

Corresponding Authors:

Zhixian Gong 1986075428@qq.com

Email Addresses for All Authors:

qvzekai@stu.hnucm.edu.cn

19860758@qq.com

198608@qq.com

1986@qq.com

198428@qq.com

1984111128@qq.com

19841111128@qq.com

1986075428@qq.com

Author Questionnaire

- 1. Microscopy:** Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **NO**

- 2. Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **NO**

- 3. Filming location:** Will the filming need to take place in multiple locations? **NO**

- 4. Testimonials (optional):** Would you be open to filming two short testimonial statements **live during your JoVE shoot**? These will **not appear in your JoVE video** but may be used in JoVE's promotional materials. **NO**

Current Protocol Length

Number of Steps: 19

Number of Shots: 43

Interviews

Videographer: Obtain headshots for all authors available at the filming location.

Authors: Statements have been edited for length and clarity. Please note that **the questions will not appear on screen. Please answer in *stand-alone full sentence with sufficient context.***

INTRODUCTION:

~~**REQUIRED:** Summarize your research focus and the main questions it aims to answer.~~

- 1.1. **Zhixian Gong:** This research focuses on demonstrating manual reduction and splint immobilization for distal radius fractures and evaluating their application in fracture management.
 - 1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera.

~~**Describe the research contexts or systems in which this protocol can be applied.**~~

- 1.2. **Zhixian Gong:** This protocol can be applied in adult orthopedic clinical practice for the management of closed distal radius fractures.
 - 1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera.

CONCLUSION:

~~**Describe the most important consideration or challenge when performing this protocol.**~~

- 1.3. **Zhixian Gong:** A key consideration is performing manual reduction and splint fixation appropriately and ensuring regular follow-up visits.
 - 1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera.

~~**How can future studies build on this work? Describe the questions or research directions that can be investigated next.**~~

- 1.4. **Zhixian Gong:** Future studies can build on this work by expanding its application to more patients through standardized guidance and training.
 - 1.4.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera.

Videographer: Obtain headshots for all authors available at the filming location.

Testimonial Questions (OPTIONAL):—

~~*Videographer: Please capture all testimonial shots in a wide angle format with sufficient headspace, as the final videos will be rendered in a 1:1 aspect ratio. Testimonial statements will be presented live by the authors, sharing their spontaneous perspectives.*~~

~~What is the key takeaway you hope viewers remember after watching your video article?~~

~~1.6 Zhixian Gong, Department Director: (authors will present their testimonial statements—live)~~

~~How does the video format of your article help you to share your work with the broader—scientific community?~~

~~1.7 Zhixian Gong, Department Director: (authors will present their testimonial statements—live)—~~

NOTE: Not filmed

Ethics Title Card

This research has been approved by the Institutional Review Board of The First Hospital of Hunan University of Chinese Medicine.

Protocol

***Videographer:** Please always record an audio slate while filming each shot mentioned in the shotlist.*

The script has been finalized based on the authors' edits.

2. Material Preparation

Demonstrator: Zhixian Gong

- 2.1. To begin, prepare 4 fir-bark splints for the volar, dorsal, radial, and ulnar [1]. Size each splint according to the dimensions of the affected forearm [2] and trim its width slightly narrower than the corresponding aspect of the affected limb [3].
 - 2.1.1. WIDE: Talent arranging the four fir-bark splints arranged and identified as volar, dorsal, radial, and ulnar
 - 2.1.2. CU: Talent measuring each splint against the dimensions of the affected forearm
 - 2.1.3. CU: Talent trimming each splint slightly narrower than the corresponding aspect of the limb
- 2.2. Apply protective padding to each splint, smooth all edges, and cover them with two layers of gauze [1]. Prepare the fixation straps, bandage, and scissors [2], and arrange all materials within reach so immobilization can begin as soon as satisfactory alignment is achieved [3].
 - 2.2.1. CU: Talent padding the splints and covering the edges with two layers of gauze.
 - 2.2.2. Talent preparing the fixation straps, bandage, and scissors
 - 2.2.3. Talent arranging all the immobilization materials within reach of the operator and assistant

3. Traction and Angular Correction

- 3.1. Ask the assistant to stabilize the elbow and proximal forearm, with the countertraction force aligned along the longitudinal axis of the forearm [1]. Grasp the distal hand with both hands without pressing directly over the fracture [2], and align the traction force with the same longitudinal axis of the forearm [3].
 - 3.1.1. Talent asking the assistant to stabilize the elbow and proximal forearm for countertraction

3.1.2. CU: Talent grasping the distal hand with both hands while avoiding direct pressure over the fracture

3.1.3. Talent aligning the traction force with the longitudinal axis of the forearm

3.2. Immediately before traction, confirm the pre-reduction neurovascular findings [1].

3.2.1. Talent confirming the pre-reduction neurovascular findings immediately before traction

3.3. Apply gradual longitudinal traction while the assistant applies equal countertraction in the opposite direction [1]. Avoid sudden or forceful pulling, and maintain traction for approximately 3 to 5 minutes, or until muscle resistance decreases and the impacted fragments become mobile [2].

3.3.1. Talent applying gradual longitudinal traction while the assistant provides equal countertraction.

3.3.2. CU: Talent maintaining controlled traction as muscle resistance decreases

3.4. Restore radial length before correcting translation and angulation [1]. Maintain continuous traction during the subsequent corrective maneuvers [2].

3.4.1. Talent restoring radial length before correcting translation and angulation

3.4.2. Talent maintaining continuous traction during the subsequent corrective maneuvers

3.5. For a dorsally displaced fracture, stabilize the proximal fragment and apply volar-directed pressure to the distal fragment [1]. Correct radial translation and dorsal angulation in a controlled sequence [2].

3.5.1. CU: Talent stabilizing the proximal fragment and applying volar-directed pressure to the distal fragment

3.5.2. Talent correcting radial translation and dorsal angulation while continuous traction is maintained

4. Reduction Confirmation and Maintenance

4.1. While maintaining longitudinal traction, inspect the wrist from the dorsal, volar, and lateral aspects [1]. Confirm that the dorsal prominence and radial deviation have improved [2], and that the wrist contour approximates that of the contralateral side [3].

- 4.1.1. Talent maintaining the traction while inspecting the wrist from the dorsal and volar aspects
- 4.1.2. CU: Talent inspecting the lateral wrist contour and the corrected dorsal prominence
- 4.1.3. Talent comparing the reduced wrist with the contralateral wrist for contour and radial deviation
- 4.2. Compare the apparent radial length and the relative positions of the radial and ulnar styloids with those of the contralateral wrist as a preliminary clinical indicator [1].
 - 4.2.1. Talent comparing the apparent radial length and the relative positions of the radial and ulnar styloids between the wrists
- 4.3. Perform and document the complete distal neurovascular assessment, including capillary refill, radial and ulnar pulses, skin color and temperature, active finger movement, median, radial, and ulnar nerve motor and sensory function [1].
 - 4.3.1. Talent performing and documenting the complete distal neurovascular assessment
- 4.4. Maintain the corrected wrist in approximately 15 to 20 degrees of palmar flexion and 10 to 15 degrees of ulnar deviation [1]. Keep the forearm neutral or in approximately 15 to 20 degrees of slight pronation [2]. **Author's NOTE:** Revise "slight supination" to "slight pronation" to conform to our clinical practice.
 - 4.4.1. Talent maintaining the corrected wrist at approximately 15 to 20 degrees of palmar flexion and 10 to 15 degrees of ulnar deviation
 - 4.4.2. Talent maintaining the forearm in a neutral position or approximately 15 to 20 degrees of ~~slight supination~~ slight pronation.
- 4.5. Maintain continuous control of the distal fragment while the assistant applies the pressure pads, protective padding, and 4 splints [1]. Do not release the reduction until all the splints and fixation straps are secured [2].
 - 4.5.1. Talent maintaining control of the distal fragment while the assistant applies the pressure pads, protective padding, and 4 splints
 - 4.5.2. Talent maintaining the reduction while the splints and fixation straps are secured.

5. Limb Preparation and Splint Placement

5.1. Maintain the reduced wrist position and apply protective padding over the fracture region and bony prominences [1]. Smooth the padding to remove folds and prevent focal pressure [2]. Confirm that the 4 fir-bark splints are trimmed according to the patient's forearm dimensions [3] and ensure that all the edges are smoothed and covered with 2 layers of gauze [4].

5.1.1. Talent maintaining the reduced wrist position and applying protective padding over the fracture region and bony prominences.

5.1.2. Talent smoothing the padding to prevent folds and focal pressure.

5.1.3. Talent confirming that the 4 fir-bark splints are trimmed according to the patient's forearm dimensions.

5.1.4. Talent confirming that all the splint edges are smoothed and covered with 2 layers of gauze.

5.2. Place the volar and dorsal splints along the corresponding aspects of the forearm while maintaining the reduction [1], leaving the fingers and elbow free for examination and movement [2]. Place the radial and ulnar splints along the corresponding sides of the forearm [3].

5.2.1. CU: Talent placing the volar and dorsal splints along the corresponding aspects of the forearm while maintaining the reduction.

5.2.2. Shot of the volar and dorsal splints in place with the fingers and elbow left free

5.2.3. Talent placing the radial and ulnar splints along the corresponding sides of the forearm.

5.3. Leave a small interval between adjacent splints to accommodate swelling and avoid circumferential compression [1]. Confirm that the splints cover the fracture region without directly compressing the radial styloid, ulnar styloid, or other bony prominences [2], and adjust the padding where necessary [3].

5.3.1. Talent maintaining a small interval between adjacent splints

5.3.2. Talent confirming that the splints cover the fracture region without directly compressing the radial styloid, ulnar styloid, or other bony prominences

5.3.3. Talent adjusting the padding where necessary

6. Splint Securing and Neurovascular Assessment

6.1. Secure the splints with the prepared fixation straps and bandage in the predetermined sequence while maintaining the corrected wrist position [1]. Tighten each strap

sufficiently to stabilize the splints while allowing approximately 1 centimeter of vertical movement [2]. **Author's NOTE:** Revise to "while allowing approximately 1 cm of vertical movement" for objective standardized measurement.

- 6.1.1. Talent maintaining the corrected wrist position while the assistant secures the splints with the prepared fixation straps and bandage
- 6.1.2. Talent tightening each strap ~~while confirming that approximately 1 finger can pass beneath it~~ while allowing approximately 1 cm of vertical movement
- 6.2. Use releasable knots to allow the construct to be loosened promptly if swelling develops [1]. After all the straps are secured, confirm that the wrist and forearm remain in the intended position [2].
 - 6.2.1. Talent securing the fixation with releasable knots
 - 6.2.2. Talent confirming the wrist and forearm position after securing all the straps
- 6.3. Immediately after splint application, reassess the capillary refill time, radial and ulnar pulses, skin color and temperature [1], and active finger movement [2]. Reassess the median, radial, and ulnar nerve motor and sensory function [3].
 - 6.3.1. Talent reassessing the capillary refill time, radial and ulnar pulses, skin color and temperature
 - 6.3.2. CU: Active finger movement being done by the patient
 - 6.3.3. Talent reassessing the median, radial, and ulnar nerve motor and sensory function
- 6.4. Following manual reduction and splint immobilization, assess the outcome by comparing the radial inclination and volar tilt on pre- and post-reduction radiographs [1].
 - 6.4.1. Talent comparing the pre- and post-reduction radiographs for radial inclination and volar tilt.

Author: The last line in Step 6.4 has been added to bridge the protocol with the Results section.

Results

7. Results

7.1. Pre-reduction radiographs demonstrated a dorsally displaced Colles-type distal radius fracture with a radial inclination of approximately 1.74 degrees [1] and volar tilt of approximately -15.24 degrees [2].

7.1.1. LAB MEDIA: Figure 3A. *Video editor: Please highlight the green measurement lines and the angle across the wrist*

7.1.2. LAB MEDIA: Figure 3B. *Video editor: Please highlight the purple measurement lines and the angle*

7.2. Following the post-reduction, radiographs showed a radial inclination of 17.7 degrees [1] and a volar tilt of 11.4 degrees, indicating acceptable fracture alignment [2].

7.2.1. LAB MEDIA: Figure 4A. *Video editor: Please highlight the green line and the angle labeled 17.7 °*

7.2.2. LAB MEDIA: Figure 4B. *Video editor: Please highlight the purple line and the angle labeled 11.4°*

7.3. Follow-up radiographs showed that the corrected alignment was maintained, with a radial inclination of 15.8 degrees [1] and a volar tilt of 11.7 degrees at 6 days [2], and at 15 days, the radial inclination was 15.2 degrees [3] and the volar tilt was 11.4 degrees [4].

7.3.1. LAB MEDIA: Figure 5A. *Video editor: Please highlight the green line and the angle labeled 15.8 °*

7.3.2. LAB MEDIA: Figure 5B. *Video editor: Please highlight the purple line and the angle labeled 11.7°*

7.3.3. LAB MEDIA: Figure 6A. *Video editor: Please highlight the green line and the angle labeled 15.2 °*

7.3.4. LAB MEDIA: Figure 6B. *Video editor: Please highlight the purple line and the angle labeled 11.4°*

1. Volar

Pronunciation link: <https://www.merriam-webster.com/dictionary/volar>

IPA: /'voulər/

Phonetic Spelling: VOH·ler

2. Dorsal
Pronunciation link: <https://www.merriam-webster.com/dictionary/dorsal>
IPA: /'dɔrsəl/
Phonetic Spelling: DOR·suhl
3. Radial
Pronunciation link: <https://www.merriam-webster.com/dictionary/radial>
IPA: /'reɪdiəl/
Phonetic Spelling: RAY·dee·uhl
4. Ulnar
Pronunciation link: <https://www.merriam-webster.com/dictionary/ulnar>
IPA: /'ʌlnər/
Phonetic Spelling: UHL·ner
5. Immobilization
Pronunciation link: <https://www.merriam-webster.com/dictionary/immobilization>
IPA: /ɪˌmoʊbələ'zeɪʃən/
Phonetic Spelling: ih·moh·buh·luh·ZAY·shuhn
6. Countertraction
Pronunciation link: No confirmed link found
IPA: /ˌkaʊntər'trækʃən/
Phonetic Spelling: kown·ter·TRAK·shuhn
7. Neurovascular
Pronunciation link: <https://www.merriam-webster.com/medical/neurovascular>
IPA: /ˌnʊroʊ'væskjələr/
Phonetic Spelling: nur·oh·VAS·kyuh·ler
8. Angulation
Pronunciation link: <https://www.merriam-webster.com/medical/angulation>
IPA: /ˌæŋɡjə'leɪʃən/
Phonetic Spelling: ang·gyuh·LAY·shuhn
9. Contralateral
Pronunciation link: <https://www.merriam-webster.com/dictionary/contralateral>
IPA: /ˌkɒntrə'lætərəl/
Phonetic Spelling: kon·truh·LAT·er·uhl
10. Styloids
Pronunciation link: <https://www.merriam-webster.com/dictionary/styloid>
IPA: /'stɑɪləɪdz/
Phonetic Spelling: STY·loydz
11. Capillary
Pronunciation link: <https://www.merriam-webster.com/dictionary/capillary>
IPA: /'kæpəˌlɛəri/
Phonetic Spelling: KAP·uh·lair·ee
12. Palmar
Pronunciation link: <https://www.merriam-webster.com/dictionary/palmar>
IPA: /'pælmər/
Phonetic Spelling: PAL·mer
13. Pronation
Pronunciation link: <https://www.merriam-webster.com/dictionary/pronation>

- IPA: /proʊˈneɪʃən/
Phonetic Spelling: proh·NAY·shuhn
14. Supination
Pronunciation link: <https://www.merriam-webster.com/dictionary/supination>
IPA: /ˌsuːpəˈneɪʃən/
Phonetic Spelling: soo·puh·NAY·shuhn
15. Circumferential
Pronunciation link: <https://www.merriam-webster.com/dictionary/circumferential>
IPA: /ˌsɜrkəmˈfɛrənʃəl/
Phonetic Spelling: sur·kuhm·fuh·REN·shuhl
16. Styloid
Pronunciation link: <https://www.merriam-webster.com/dictionary/styloid>
IPA: /ˈstɑɪləɪd/
Phonetic Spelling: STY·loyd
17. Radiographs
Pronunciation link: <https://www.merriam-webster.com/dictionary/radiograph>
IPA: /ˈreɪdiəˌɡræfs/
Phonetic Spelling: RAY·dee·uh·grafs
18. Radial inclination
Pronunciation link: No confirmed link found
IPA: /ˈreɪdiəl ˌɪnkləˈneɪʃən/
Phonetic Spelling: RAY·dee·uhl in·kluh·NAY·shuhn
19. Volar tilt
Pronunciation link: No confirmed link found
IPA: /ˈvɒləɹ tɪlt/
Phonetic Spelling: VOH·ler tilt
20. Colles-type
Pronunciation link: <https://www.merriam-webster.com/dictionary/Colles%27%20fracture>
IPA: /ˈkɒlɪz taɪp/
Phonetic Spelling: KAA·leez type