Clinical Literature Review on Ultrasound Guided Manipulation of Distal Radius Fracture

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ABSTRACT

Distal radius fracture is a very common presentation in the emergency department. The desired manipulation is important for the outcome of the functionality of the fractured wrist. In some countries, image intensifier/fluoroscopy is used to gain appropriate alignment. As fluoroscopy is not available in most of the emergency department in the UK an alternative was hunted; ultrasound seems to be more reliable, readily available and cost-effective. An ultrasound machine is a handy tool in emergency department settings and available throughout the country. A review was carried out to identify the capability of PoCUS- point of care ultrasound in successful reduction and reduced re-manipulation attempt of distal radius fracture. Different factors like physician training time and the difference between conventional blind manipulation were considered.

Keywords: PoCUS, Distal radius, Fracture manipulation, Ultrasound

1. INTRODUCTION

Distal radius fracture is a very common presentation especially in the elderly population attending in the emergency department. In fact, distal radius fracture (International Classification of Disease code 813, fractures of the radius and/or ulnar) is one of the most common musculoskeletal injury [1,2]. Conservative treatment with closed reduction and cast immobilization remains the most common form of definitive treatment [3,4]. Post-manipulation radiographs are then obtained to assess the adequacy of the reduction [5]. However, multiple inadequate reductions under blind manipulation can result in prolonged sedation time, increased radiation exposure, and patient discomfort [6]. Dorsal angulation of the distal radius results in progressive incongruity of the radioulnar joint and has been shown to correlate with decreased grip strength, range of motion, and activities of daily living [7,8]. To deliver the best possible care in the emergency department (in terms of reduction of fracture distal radius) ultrasound can be used to guide reduction or to help with real-time manipulation. On top of that ultrasound is also widely available in most of the emergency departments. As per current practice in most of the emergency departments in the UK, distal radius fracture is manipulated blindly. PoCUS in distal radius fracture manipulation is practiced in different centers of several countries.

To adopt this practice, the literature review was conducted to infer the effectiveness of ultrasound because it could be an ideal tool (widely available, cost-effective & no radiation risk compared to fluoroscopy) for the patients need manipulation. The objective of this clinical literature review as a three-part question is if ‘In an adult patient with distal radius fracture, can ultrasound guided manipulation be used for successful reduction & reduce re-manipulation attempt?’
2. METHODS

PICO question was formulated to answer the question in the topic.
Population: In patients (adult) presenting to the emergency department with distal radius fracture.
Intervention: Ultrasound-guided manipulation.
Comparison: Unassisted blind manipulation.
Outcome: Successful reduction, reduce re-manipulation attempt. A comprehensive search strategy was developed. Three databases were searched to date: Medline, EMBASE, PubMed, CINHAL, Cochrane and Bestbets. NICE evidence website was used (HDAS).

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Origin</th>
<th>Design</th>
<th>Population Group</th>
<th>Sample size</th>
<th>PoCUS</th>
<th>Fluoroscopy</th>
<th>Blind Manipulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tai-Chang Chern et al.[9]</td>
<td>2002</td>
<td>Taiwan</td>
<td>Prospective observational study</td>
<td>Adult and children</td>
<td>27</td>
<td>27§</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Methods

Table 1: The Search Term

| *=“WRIST FRACTURE”/ or *=“RADIUS FRACTURE”/ or *=“DISTAL RADIUS FRACTURE”/ or *=“COLLES FRACTURE”/ or *=“SMITH FRACTURE”/ or (“wrist fracture”),ti,ab |
| AND |
| *=“CLOSED FRACTURE REDUCTION”/ or *=“CLOSED REDUCTION (PROCEDURE)”/ or *=“FRACTURE REDUCTION”/ or (manipulation),ti,ab or *=“FRACTURE REDUCTION”/ or *=“MANIPULATION, ORTHOPEDIC”/ |
| AND |
| *=“ULTRASONOGRAPHY”/ or (“ultrasound-guided”),ti,ab or (“ultrasound guided”),ti,ab or (“ultrasound assisted”),ti,ab or (“ultrasound-assisted”),ti,ab |

Inclusion and Exclusion Criteria:
The studies that were included in the review had the following criteria: Studies included distal radius fracture, all randomized trials, cohort, case-control studies; all studies with any type of block, anaesthesia or sedation, all studies included adult patient (Age >18), studies that are conducted in the hospital. Studies that were excluded are: Studies looked at only paediatric cases, case reports, case series, opinions and letters to the editors, studies which include open fracture, studies which includes immediate surgical intervention, studies looked at other than distal radius fracture of the forearm.

3. RESULTS

Data extraction and the critical appraisal was done for each selected literature. From each included publication data following data were extracted: study author, study year, study demography, study design, population group, sample size, and sample size distribution in different groups. All the articles were analysed and critically appraised by CASP (Critical Appraisal Skills Programme) checklist based on the study type.
4. DISCUSSION

Total seven papers were apprised among them four cohorts, two case-control, and one prospective observational study. All the studies have a definite objective, acceptable methodology, and clear outcome. There are flaws in the trial like no power calculation, small sample size, no or single blinding, no parallel control group (Socransky et al.), considering both adult and paediatric patient (Chinnock et al, Chern et al). Five studies showed that success rate of using ultrasound in distal radius fracture reduction. One study compared ultrasound with fluoroscopy which showed similar success rate (95% and 94% respectively) but less expensive. Two studies mentioned a reduction of the need for ORIF (Open reduction internal fixation) following ultrasound use during manipulation. Four studies calculated different indices in radiograph like volar displacement, dorsal displacement, radial displacement and found significant improvement in one or all indices except one. Three studies inferred, re-manipulation attempt was reduced. One study found increase number of manipulation (41.2%, P <0.001) needed when PoCUS (Point of care ultrasound) was introduced after successful blind reduction. One study compared to the time required for ultrasound-guided manipulation (Mean= 18 minutes) and blind manipulation (Mean= 10 minutes) but as PoCUS reduce the need for re-manipulation attempt can help with 4-Hour A&E target. In all studies time for physician training required was minimum.

<table>
<thead>
<tr>
<th>Articles apprised</th>
<th>Manipulation Success rate</th>
<th>Need for ORIF</th>
<th>Improvement of radiographic indices</th>
<th>Reduce Re-manipulation attempt requirement</th>
<th>Interrater reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chern al (2002) Taiwan</td>
<td>P &lt;0.05</td>
<td></td>
<td></td>
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<tr>
<td>Ang et al (2009) Singapore</td>
<td>P=0.019</td>
<td>Volar tilt 95% CI 3.31 (0.34-6.59)</td>
<td>P=0.056</td>
<td></td>
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<tr>
<td>Chinnock et al (2009) USA</td>
<td>83%, 95% CI 69-91</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Kodama et all (2009) Japan</td>
<td>95%</td>
<td>68%</td>
<td>P&gt;0.05</td>
<td></td>
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<tr>
<td>Sabzghabaei et al (2015) Iran</td>
<td>P=0.025</td>
<td>Volar tilt &lt;0.001</td>
<td>P=0.019</td>
<td></td>
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<tr>
<td>Socransky et al (2016) Canada</td>
<td>P=0.014</td>
<td>Certainty of reduction by ultrasound, Odds ratio 12.5</td>
<td>P&lt;0.001</td>
<td></td>
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</tbody>
</table>
**Strenght and weakness of different studies in the review**

Strengths of the study is: prospective study and well-defined exclusion and inclusion criteria. On the other hand; it has no control group with a small sample size, only assessor of the images was blinded and included both adult and paediatric patient. Methodologies allow for reasonable internal validity but not recruited convenient sample with a heterogeneous group of population (adult and children) leads to less generalizability with external validity. Pre and post-reduction measurement in ultrasound and x-ray correlates, which signifies that ultrasound can be used at least as a reliable adjunct tool. Authors suggested sonography as an effective tool in distal radius fracture reduction monitoring which is acceptable and homogenous with other study results.

Strengths of the study: It was a clear focused Cohort study, the standard for acceptable radiographic reduction was clearly defined. The weakness of the paper that can be highlighted are that the control group was taken retrospectively, power was calculated but less patient was recruited in ultrasound group (62 instead of 96), no cost analysis or time in the emergency department were calculated. This study has good internal and external validity. Authors suggested ultrasound guided manipulation was effective and should be routinely used. Considering a few flaws, the study recommendation is acceptable.

Strengths of the paper: A prospective ED-based study addressing a clearly focused issue, study methods has well-defined inclusion and exclusion criteria. The weakness of the paper: No calculation of the power of the study, no definition or set criteria to measure successful reduction (Subjective), single-blinded study. It has limited external validity as both paediatric and adult patient included from two urban medical centers EDs although the mean age of patients were 30-32 years and 20-21 years, male and female respectively. Which creates a selection bias. The result of the study showed a similar success rate in both groups but indicates the need for further larger study. The study also showed ED physician’s US-guided findings has an excellent correlation to final radiographic findings.

Strengths of the paper: Definition of successful reduction was objective in the study, a reasonable number of case and control is included (n = 100). The weakness of the paper: Only two hand surgeons were involved in the ultrasound group. (Intrarater and interrater reliability can’t be implacable for external validity). Control was taken retrospectively. As two hand surgeons performed ultrasound-guided manipulation which reduce the external validity of the study in the emergency department. Power of the study was not calculated.

**Paper 5: Brian C. Lau et al (2017) USA**
Strengths of the paper: Prospective single blinded case-control study where authors used objective measurement. Blinding was done as none of the accessors have examined the patient. The weakness of the paper: Cases were recruited prospectively. Power of the study was not calculated so chances of type II error is present. Control was healthy subjects without fracture with wrist pain which increase the chances of Berkson's bias. The study only used handheld/ pocket ultrasound (12.5 Mhz) which might reduce external validity. The study comes up short in providing evidence that the study result is reproducible in the emergency department as a musculoskeletal radiologist and hand surgeon were involve.

**Paper 6: Anita Sabzghabaei et all (2015) Iran**
Strengths of the paper: Prospective case-control study. There were objective measurements and truly reflects what they were trying to measure in the question. No significant difference between the groups. Definite inclusion & exclusion criteria. N=130 which increases the internal validity. The weakness of the paper: Did not mention how they have selected case and how they have selected control among n=130. Power was not calculated. Despite some weakness, this study has good internal and external validity. So, the result can be generalized. The study result has homogeneity with the other studies done in the same issue.

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**Paper 7: Steve Socransky et al. (2016) Canada**

Strengths of the paper: Prospective multicentre cohort study where multiple physicians were involved and had formal training. Convenience sample size (n=131). The weakness of the paper: No blinding and no parallel control group. Subjective measurement of distal radius fracture reduction (Likert scale). The study has good internal validity with a convenience sample size (n=131). Assessment of the study was subjective. Authors suggest further study but the study result was significant as there was a 40% increase in re-manipulation in the 1st attempt after addition of PoCUS following satisfactory blind reduction and clinical assessment.

**Level of evidence and recommendation**

Considering all the evidence available for use of ultrasound in the manipulation of distal radius fracture are based on prospective cohort, case-control & observational study. Considering multiple flaws in the appraised studies, the level of evidence is a 2B1 and the conclusions are grade B recommendation. What is required is an appropriately powered RCT to assess the sensitivity, specificity, PPV and NPV.

**5. CONCLUSION**

PoCUS in the reduction of distal radius fracture is a reliable & cost-effective tool. Moreover, the advantage is, time for physician training required is minimal. PoCUS can improve the alinement of reduction with reducing the number of re-reduction hence improve 4-hour A&E target. Considering flaws in the studies, all showed positive results of Using PoCUS in terms of alignment, time in the emergency department, need for ORIF and even ultrasound indices are reasonably comparable to conventional radiograph. After critically apprising these articles it is reasonable to recommend ultrasound in distal radius fracture reduction. Randomized control trial is recommended.

**REFERENCES**

17. Center of evidence based medicine (CEBM)