International Journal of Research in Orthopaedics
Shaikh MJ et al. Int J Res Orthop. 2024 Nov;10(6):1181-1186
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20242670

Original Research Article

Prevention of screw penetration of the dorsal cortex in volar plating of distal end radius fracture by using dorsal tangential view

Mujahidpasha Javed Shaikh*, M. A. Naser, Mujtaba Hussain Patel, Amol Salve, Pramod Tupe, Mehnaaz Parkar

Department of Orthopaedics, Indian Institute of Medical Sciences and Research, Warudi, Jalna, Maharashtra, India

Received: 18 August 2024
Revised: 03 September 2024
Accepted: 04 September 2024

***Correspondence:**
Dr. Mujahidpasha Javed Shaikh,
E-mail: mj21shaikh@gmail.com

ABSTRACT

Background: The dorsal cortex penetration by a screw can leads to irritation and attritional extensor tendon injury in volar plating of distal end radius fracture. Our method in this study was to use dorsal tangential view (DTV) intraoperatively to detect screw protrusions in the dorsal cortex and replace these screws with screws of appropriate size.
Methods: We have enrolled 60 patients from in patient department of orthopaedics in a rural tertiary care institute (Indian Institute of Medical Science and Research Warudi, Ta. Badnapur, Dist. Jalna, Maharashtra) having distal end radius fracture above 18 years of age planned for volar plating. DTV other than standard PA, lateral view was taken to evaluate the dorsal cortex penetration.
Results: Seven patients required AP and lateral view while 14 patients needed DTV with 80% power (α=0.05, β=0.2).
Conclusions: Our study concluded that additional DTV apart from standard AP and lateral view will detect the dorsal penetration of screws and can be changed intraoperatively. Thus, DTV is advised to minimise the iatrogenic extensor tendon injury by dorsal screw penetration which might be missed in lateral view.

Keywords: Distal end radius fracture, Volar plating, DTV, Screw penetration

INTRODUCTION

Distal end radius fracture is one of most common fractures resulting from fall on an out-stretched hand.[1-8] There is bimodal distribution with high energy trauma being mechanism of injury in young patients and fall from standing height in elderly population. With rise in the prevalence of osteoporosis and longevity of life we expect a rise in the incidence of these fractures.[1,3,4,9]

The indicators of instability are intra articular shear fracture, dorsal metaphyseal comminution, severe osteoporosis, dorsal angulation of more than 20degree, radial height shortening of more than 10mm and ulna styloid fracture.[10] Recently volar locking plates have become a treatment of choice in unstable distal end radius fractures.[11-13] Volar locking plate bridges the metaphyseal comminution. This plate is supported by locking distal screws which supports articular surface and nonlocking proximal cortical screws. Stable peri articular reduction helps in early post operative wrist mobility which helps in early gain of wrist function. Goal of fracture fixation is to achieve anatomic reduction with following parameters.

Table 1: Parameters for anatomic fracture reduction.

Parameters	Ideal	Acceptable
Palmar tilt	11 degree	Neutral
Ulnar variance	±2 mm	-2
Radial height	12 mm	
Radial inclination	20 degree	10 degree
Intra articular step	None	≤2 mm

Indications

Indications were dorsal angulation >20 degree, radial inclination <20 degree, ulnar variance >5 mm, articular step >2 mm and loss of reduction on follow up radiographs.

Contraindications

Contraindications were acceptable radiographic parameters after closed reduction and immobilization, medical comorbidities precluding surgery, soft tissue condition precluding surgical approach and dorsal shear fractures.[14-18]

A well-recognised complication of volar plating is irritation and attritional extensor tendon injury due to screw penetration into dorsal cortex with rare complication of loss of wrist function following intra articular screw placement.[19-25] In standard PA and lateral view the dorsal penetration of screws is obscured by lister's tubercle. Hill and colleagues carried out a cadaveric study in 2015 for DTV to prevent dorsal cortex penetration by screws.[26] Ozer and colleagues performed a cadaveric study for DTV and found it to be helpful.[27] This study compared the DTV view, supination, pronation, and lateral views. DTV view is found to be effective in detection of dorsal cortex penetration by screws. In this study, we use DTV intra-operatively to detect screw penetration of dorsal cortex and exchange these screws with screws of appropriate size.

METHODS

Study design

It was a prospective observational study

Study setting

Study carried out at department of orthopaedics in a rural tertiary care institute (Indian institute of medical science and research Warudi, Ta. Badnapur, Dist. Jalna, Maharashtra).

Study population

In-patient department of orthopaedics having distal end radius fractures were included in study.

Study duration

Study conducted for 12 months (May 2023 to May 2024).

Sampling technique

It was a simple random sampling.

Sample size

Total 60 patients were included in study.

Study was approved by ethical committee at our institute

In the entire study, p values less than 0.05 are considered to be statistically significant. The entire data is statistically analysed using statistical package for social sciences (SPSS ver 24.0, IBM corporation, USA) for the MS Windows.

Distal radius fractures represent the most common fractures in adults, with an overall prevalence of 17.5% with respect to all fractures.[34,35]

Sample size, $n=Z^2 PQ/E^2$

P=17.5, Q=82.5 (1-P), Z=1.96 and E=10

$n=\underline{1.96^2\times17.5\times82.5/}10^2$

n=55.4631

To round up the figure, we decided to work with a sample size of 60 subjects (n=60).

Thus, in this prospective observational study, 60 patients were enrolled during study duration based on inclusion criteria. Patients above the age of 18 years with unstable distal end radius fractures with extra-articular or intra-articular extension, planned for volar locking plate were included.

Inclusion criteria

Patients aged 18 years and above with; intraarticular shear fracture, extra articular fracture with intra articular extension, severe osteoporosis with distal end radius fracture, metaphyseal comminution of distal end radius fracture, dorsal angulation of $>20^0$ in distal end radius fracture and radial shortening of >10 mm were included in study.

Exclusion criteria

Distal end radius fracture with; acceptable stable closed reduction, neurovascular compromise, compound fractures, previous extensor tendon injuries, stiffness of metacarpophalangeal and proximal interphalangeal joint unfit patients due to medical comorbidities and patients who are unwilling or unable to provide informed consent.

Surgical treatment

All distal end radius fracture were operated after fitness under regional block by a single experienced orthopaedic surgeon. By using volar (modified Henry's) approach, fracture was exposed, reduction achieved under c arm guidance and fixed with variable angle volar plate. Cortical and locking screws were utilized to secure the plate. Screw lengths of initial and exchanged screws were recorded.

Imaging technique

Intra operatively DTVs were taken other than standard PA and lateral views. Brunner and colleagues have recommended DTV as: the forearm in 75 degrees inclination to the horizontal arm table and the wrist in maximum flexion. The X ray beam of fluoroscope positioned vertically and dorsal cortex of radius inclined to 15 degree.[28] Brunner and colleague also recommend to shoot a continuous view while changing the angle between 5 to 20 degree to account for variation in anatomy.[28]

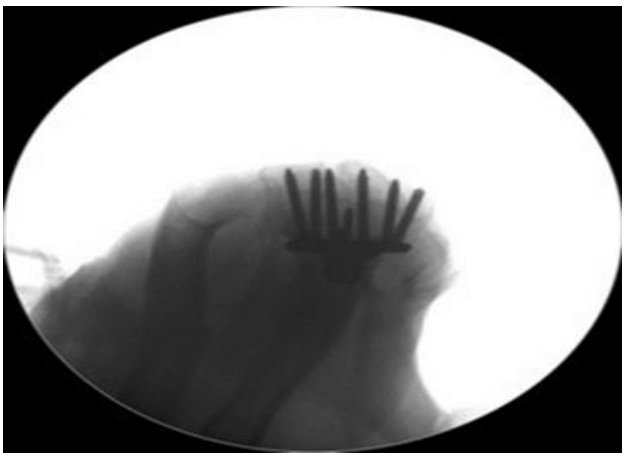

Figure 1: Intra op DTV.

Figure 2: Position of forearm, wrist and hand for DTV.

RESULTS

The present study was a hospital based prospective observational study that included a total of 60 cases of distal end fracture, aged between 18 to 83 years and those who satisfied inclusion/exclusion criteria. The cases were of either gender, with predominance of male cases (male to female sex ratio being 1.06:1.00).

It was aimed to detect dorsal screw penetration intra operatively with DTV taken other than PA view and Lateral view in a case of volar plating for distal end radius fracture, over a period of 18 months.

In the entire study, p values less than 0.05 are considered to be statistically significant. The entire data is statistically analysed using statistical package for social sciences (SPSS ver 24.0, IBM corporation, USA) for MS Windows.

Following section shows the detailed statistical analysis along with interpretation and graphical representation of the statistical results on the available data.

Out of 60 cases studied, 1 cases (1.66%) had age below 20 years, 5 cases (8.33%) had age between 21-30 years, 5 cases (8.33%) had age between 31-40 years, 2 cases (3.33%) had age between 41-50 years and 14 case (23.33%) had age between 51-60 years, 20 cases (33.33%) had age between 61-70 years, 10 cases (16.66%) had age between 71-80 years, 3 cases (5%)had age above 81 years in the study group.

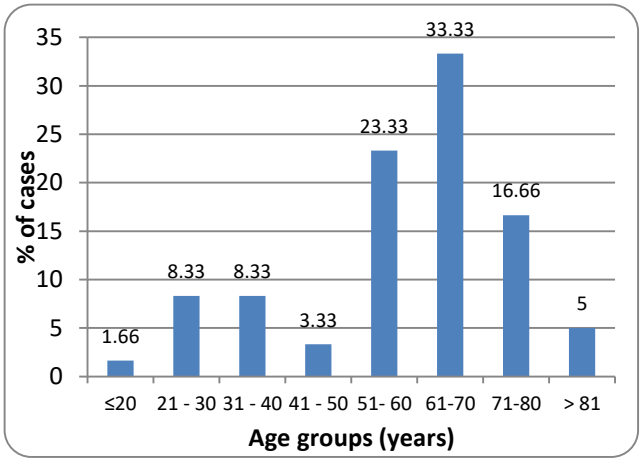

Figure 3: Age distribution of cases studied.

Sex distribution

Out of 60 cases studied, majority of cases i.e. 31 cases (51.66%) were males and 29 cases (48.33%) were females. The male to female sex ratio was 1.06:1.00

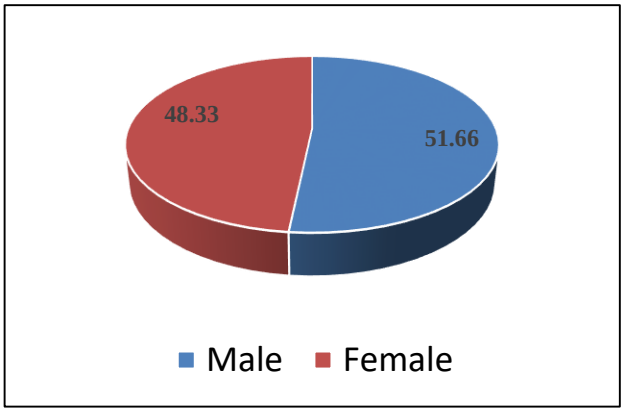

Figure 4: Sex distribution of cases studied.

Distribution of site of injury

Out of 60 cases studied, 29 cases (48.33%) had right side affected and 31 cases (51.66%) had left side affected in the study group.

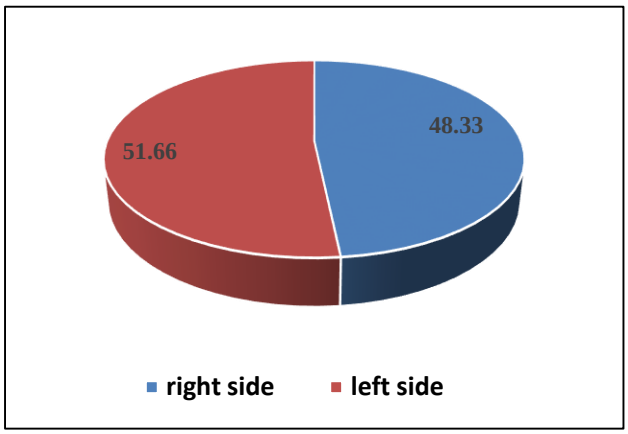

Figure 5: Distribution of side of injury of cases studied.

Analysis revealed that in 35% patients operated for distal end radius fracture, dorsally protruded screws were identified and changed. 07 patients required AP and lateral view while 14 patients needed DTV with 80% power (α=0.05, β=0.2).

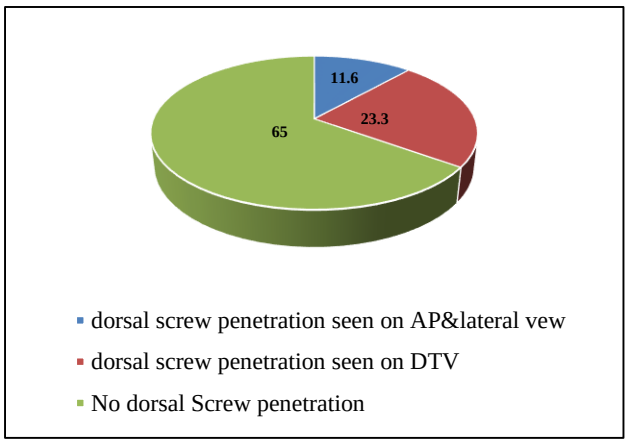

Figure 6: Distribution of dorsal screw penetration seen on AP and lateral and DTV.

DISCUSSION

The delayed iatrogenic complication of volar plating is delayed rupture of extensor tendons.[19,29] Two examples of EPL tendon rupture following distal radius volar plate fixation were described by Benson et al.[21] According to their description, the prominent screw point entering the third extensor compartment or drill bit penetration following surgery are two possible reasons of EPL tendon rupture. Al-Rashid et al conducted a retrospective evaluation of 35 patients who had volar locking plate treatment for distal radius fractures. One patient among them eventually showed up a year after surgery with ruptures of the EDC and EIP tendons.[19] The tendon may be progressively abraded over time by the screw point, even if it is smooth and only slightly beyond the dorsal cortex.

To avoid this dangerous complication, screws of the proper length must be used. To keep extensor tendon discomfort at a minimum, a screw point that protruded by less than one or two millimeters may be suitable. Thus, good intraoperative radiological analysis is essential to prevent dorsal screw penetration. Some clinical studies have concluded that standard AP and lateral views are insufficient to identify dorsal penetration of screws because of complex bony anatomy of distal radius like lister's tubercle and EPL groove.[26-33] Brunner, Alexander et al conducted a study and concluded that the dorsal radial cortex could be assessed *in vivo* with the use of the DTV, and the distance between the screw tip and the dorsal cortex could be accurately measured.[28] The quality of DTV is subjected to the positioning of patient.

The 60 patients were included in the study, 14 patients (23.33%) required DTV other than 07 patients (11.66%) in which dorsal protrusion detected by standard AP and Lateral view. Our study concluded that additional DTV apart from standard AP and lateral view will detect the dorsal penetration of screws and can be changed intraoperatively. Thus, DTV is advised to minimise the iatrogenic extensor tendon injury by dorsal screw penetration.

Limitation of this study are smaller number of patient and short duration of follow up. And as was previously said, 15° angle of forearm to x ray projection might not have been the best option in every situation due to anatomical variance. because of this dorsal cortex screw penetration cannot be detected. Rather, to determine if screw points pierced the dorsal cortex, we advise doing a live view while varying the angle between 5° and 20° in routine clinical practice.

CONCLUSION

Our study concluded that additional DTV apart from standard AP and lateral view will detect the dorsal penetration of screws and can be changed intraoperatively. Thus, DTV is advised to minimise the iatrogenic extensor tendon injury by dorsal screw penetration which might be missed in lateral view.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Shaikh MJ, Naser MA, Patel MH, Salve A, Tupe P, Parkar M. Prevention of screw penetration of the dorsal cortex in volar plating of distal end radius fracture by using dorsal tangential view. Int J Res Orthop 2024;10:1181-6.