

COMPARISON BETWEEN INCIDENCE OF POSTERIOR INTEROSSEOUS NERVE INJURY FOLLOWING VOLAR APPROACH AND DORSAL APPROACH IN FIXING FRACTURES OF PROXIMAL HALF OF RADIAL SHAFT

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ABSTRACT

BACKGROUND

Open reduction and internal fixation, with plates and screws, is the preferred standard method of treatment of displaced fractures of the shaft of the forearm bones. Proximal half of shaft of radius can be approached either by volar (anterior) or dorsal (posterior) approach. Posterior Interosseous Nerve (PIN) injury is a common complication of both the approaches. The aim of this study was to compare incidence of Posterior Interosseous Nerve (PIN) injury following any one of the approaches used for open reduction and internal fixation (ORIF) of fractures involving proximal half of shaft of the radius.

METHODS

This prospective randomised study was conducted from July 2015 to June 2017, at Department. of Orthopaedics, Calcutta National Medical College and Hospital. Open reduction and internal fixation was done on fifty (50) patients, who presented with fracture of proximal half of radial shaft, with 3.5 mm Limited Contact Dynamic Compression Plate (LCDCP) or 3.5 mm Dynamic Compression Plate (DCP) and corresponding screws. Volar approach was done on twenty-five patients and in the rest, dorsal approach was used. Comparison of PIN Palsy in each approach was the primary concern.

RESULTS

PIN palsy occurred in 2 patients of VA (volar approach) and 3 patients of DA (dorsal approach). Two patients in each group had infection, which resolved to conservative methods and one patient of VA group and 2 patients in DA group had non-union.

CONCLUSIONS

Incidence of PIN palsy was higher in DA in our study, but further study is needed.

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BACKGROUND

Open Reduction and Internal Fixation (ORIF) using appropriate plates and screws is the standard preferred method of treatment of displaced forearm fractures, because of poor results following closed reduction and casting.^{1,2} Anderson concludes in a study that ORIF is the most physiologically compatible type of internal fixation of Forearm fractures.³

Open approaches to proximal Radius are necessary for a variety of reasons, including fracture fixation, treatment of non-union, and delayed union, tumour biopsy and treatment, treatment of osteomyelitis, repair of bicipital tuberosity, nerve exploration and radius osteotomy.⁴

Proximal forearm fractures accounts for 5% of fracture per year.⁵ Surgical approaches can be selected according to the type of fracture and soft tissue damage.⁶ Controversy lies in the approach to fixation of proximal half of the radius (either Volar or Dorsal), and each one of them has its own advantages and disadvantages.

METHODS

This study was conducted at Calcutta National Medical College and Hospital, to compare the incidence of PIN palsy following operation by volar approach (VA) and dorsal approach (DA), in fractures of proximal half of the Radius shaft. Ethical clearance was obtained from the Institute ethics committee.

This prospective study was conducted on fifty consecutive patients, who presented with closed fractures (maximum 14 days old) of Proximal half of diaphysis of Radius at the emergency or OPD of department of orthopaedics, Calcutta National Medical College and Hospital, between July 2015 and June 2018.

Twenty-five patients underwent ORIF for management of fracture by VA and the rest twenty-five were operated

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through DA. The patients underwent surgical fixation either by regional anaesthesia (Brachial Plexus Block) or General Anaesthesia.

The sample selection was based on the following inclusion and exclusion criteria:

Inclusion Criteria

1. Patient above 10 yrs. of age.
2. Patients having closed fracture of proximal half of shaft of radius.
3. No concomitant injuries in the same upper limb.
4. Patients with no distal neurovascular deficit, in the fractured upper limb.

Exclusion Criteria

1. Fractures of more than 14 days duration.
2. Patients with open fractures of the Radius.
3. Concomitant injury in same upper limb.
4. Patients with distal neurovascular deficit.

After obtaining written, informed consent from the patients, every alternate patient was selected for volar approach and the others for dorsal approach.

Fractures in all the 50 patients were fixed with 3.5mm LCDCP or DCP, the length depending upon the fracture geometry. Six to eight screws were used for fixation of the plate. In 4 cases in both the groups, inter fragmentary screws were used to address the butterfly fragments and comminutions. Tourniquet was used in all the cases after achieving gravity exsanguination. Tourniquets were removed just prior to closure. The wound was closed after assessment of vascularity and achieving haemostasis.

Standard operative duration was 35 minutes to 1 hour. Immediately following surgery, the vascularity was again assessed, and neural status examined once the anaesthetic effect waned off. Post fixation no POP slab was applied routinely, and the patients were encouraged to move fingers, wrist and elbow as the pain permits. In case a loss of dorsiflexion of MCP (meta carpo phalangeal) joints were noted (suspected PIN palsy), a volar POP slab (with wrist in dorsiflexion and MCP joints in extension) was applied immediately which was later changed to dynamic wrist cock-up splint. All the operated limbs were routinely kept elevated till 48 hours of surgery.

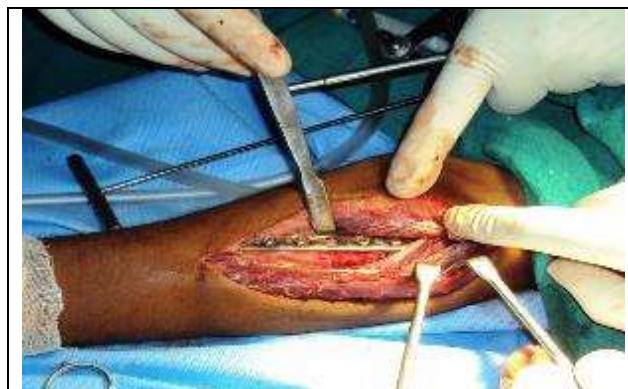
Check X-rays were taken immediately following stabilization of general condition of the patient following surgery, to check fracture alignments, and to rule out any urgent intervention for any adjustments.

The first wound inspection was done on 4th Post-operative Day, and patients with healthy wounds were discharged from the hospital. The sutures were removed on the 14th post – operative day. Then on the patients were advised to wear a forearm brace, avoid any heavy work in affected limb, actively do finger, wrist, elbow and shoulder exercises and also practice passive finger and wrist stretching, and passive shoulder movements.

The 2nd and 3rd follow-up was done at 6 weeks and 12 weeks. (Post operatively) respectively. Then patients were advised to report at every 3-month intervals. Collected data were analysed and statistical test were done with the help of SPSS 18 software.

In all the patients, radiographs and functional outcomes were reviewed and assessed at periodic intervals. Union was defined by radiographic evidence of healing of three cortices and absence of any tenderness at fracture site.

All the patients were followed up at regular intervals post-operatively, and information regarding pain, prominence of implants, numbness at incision site or paraesthesia and any loss of function was noted.



Photograph 1. Fixation of Fracture by Small DCP and Screws Through DA. The PIN is Visualised Passing Over the Proximal Part of The Plate



Photograph 2. Fixation of Proximal Radius with Small DCP Using VA

RESULTS

We had included 50 patients in our study. Of them, 25 had ORIF using volar approach and the other 25 had ORIF via dorsal approach. Data was collected for each patient regarding age, sex, side involved, mechanism of injury, associated co- morbidities, time from initial insult to surgery.

Age Distribution (Yrs.)	Volar (n=25)	Dorsal (n=25)	Total	p Value
11-20	3 (12%)	5 (20%)	8 (16%)	1.000
21-30	8 (32%)	8 (32%)	16 (32%)	
31-40	7 (28%)	7 (28%)	14 (28%)	
41-50	4 (16%)	4 (16%)	8 (16%)	

51-60	2 (8%)	1 (4%)	3 (6%)
61-70	1 (4%)	0 (0)	1 (2%)

Table 1. Age Distribution

Table 1 showed the age distribution of the patients. Most of the patients were between 21 to 30 years of age (32%) and least were between 61 to 70 years of age, P value 1 (statistically not significant).

Sex	Approach		Total	P Value
	Volar	Dorsal		
Female	11(44%)	7(28%)	18(36%)	0.377 (Yates's Correction)
Male	14(56%)	18(72%)	32(64%)	

Table 2. Sex Distribution

In table 2, we analysed the sex distribution. There were 32 male patients (64%) and only 18 female patients, P value not significant statistically (P = 0.377).

		Approach		Total	p Value
		Volar (n=25)	Dorsal (n=25)		
Forearm	Left	9 (36%)	10 (40%)	19 (38%)	0.771 (Yate's Correction)
	Right	16 (64%)	15 (60%)	31 (62%)	

Table 3. Side Involved

In table 3, We found that among the operated forearm, 31 were right (62%) and 19 were left (38%), P value being statistically insignificant as per Yate's correction (P = 0.771).

PIN Palsy	Approach		Total	p Value
	Volar	Dorsal		
No	23 (92%)	22 (88%)	45 (90%)	0.637 (Yate's Correction)
Yes	2 (8%)	3 (12%)	5 (10%)	

Table 4. Incidence of Posterior Interosseous Nerve Palsy

In table 4, the authors found that incidence of PIN palsy was higher in the Dorsal Approach (12%) in comparison to the Volar approach (8%), though the finding was statistically insignificant (p= 0.637).

Complications		Approach		Total	p Value (Yate's Correction)
		Volar	Dorsal		
Infection	No	23 (92%)	23 (92%)	46 (92%)	1.000
	Yes	2 (8%)	2 (8%)	4 (8%)	
Implant Prominence	No	25 (100%)	24 (96%)	49 (98%)	0.312
	Yes	0 (0%)	1 (4%)	1 (2%)	
Pain and Paraesthesia at Incision Site	No	24 (96%)	23 (92%)	47 (94%)	0.552
	Yes	1 (4%)	2 (8%)	3 (6%)	
Loss of Extension of MCP Joints (All Transient)	No	23 (92%)	22 (88%)	45 (90%)	0.637
	Yes	2 (8%)	3 (12%)	5 (10%)	
Transient Loss of Supination-Pronation Arc	No	21 (84%)	23 (92%)	44 (88%)	0.702
	Yes	4 (16%)	2 (8%)	6 (12%)	
Non-Union	No	24 (96%)	23 (92%)	47 (94%)	0.971
	Yes	1 (4%)	2 (8%)	3 (6%)	

Table 5. Complication in Volar and Dorsal Approach

In table 5, on analysis, we found that two patients from both groups were reported with infection, a statistically insignificant P value (P = 1.000), which was superficial in nature and responded to conservative management. There was only one case of implant prominence, in the DA group (4%), and none in the VA group, where P value was 0.312.

Two patients (8%) in DA group and 1 patient (4%) in VA group, experienced pain and paraesthesia at the incision site, not a statistically significant finding (P = 0.552).

There were 2 patients with loss of extension of metacarpophalangeal (MCP) joints. PIN palsy among the VA group (8%) and 3 patients amongst DA group (12%). All the

cases recovered by six weeks of surgery. This finding also was of no statistical significance ($P = 0.637$).

An important point noted was limitation of pronation and supination movement of the forearm in the first few weeks following surgery, which was more in the VA group, 4 in no. (16%) compared to 2 in DA group (8%), a statistically insignificant finding ($P = 0.702$), though the severity reduced gradually, and by 3 months both groups achieved similar range of rotatory movement of the forearm.

Non-union was noted in 1 patient (4%) in VA group and in 2 patients (8%) in DA group, in this study ($P = 0.971$), statistically insignificant.

DISCUSSION

The posterior or dorsal approach (DA) to proximal radius, first demonstrated by Thompson⁷ in 1918, was traditionally recommended, because of theoretically improved exposure and because the dorsal aspect of radius being the tensile surface⁴. Posterior Interosseous nerve (PIN) can be visualized and protected using this approach, by dissecting out the nerve by dividing the supinator muscle from distal to proximal or vice versa. However, it is at risk as proximal part of dorsally placed plate may irritate the nerve, due to which, plate removal becomes a necessity at times. Mekhail et al suggested that Henry's approach is the recommended lateral plating from this approach to avoid impingement on the biceps tendon. They also warned against plate removal through the posterior approach due to the risk of prior scar making PIN identification difficult.⁸

Elgafy et al in another report, emphasized how best to protect the PIN a longer distance from the radio capitellar joint than in our study; however, our measurement reflect the nerve's position as it crosses the surgical field on the bone rather than the nerve's emergence from the supinator, a point more distal. These reports are important guides for decreasing iatrogenic injury during fracture fixation and prudent exposure.⁹

Spinner et al reported that the PIN is located directly adjacent to the radial neck in 25% of patients, putting the nerve at risk of entrapment under a plate if fracture fixation requires proximal plate positioning,¹⁰ which was taken into consideration and precautions taken in our surgical approach.

Dietz et al compared fixation of forearm fracture in volar and dorsal approaches and found that mal-positioning of plates occurred more in the dorsal approach which leads to the impaired rotational kinematics of the forearm,¹¹ though the authors here found rotational problems more with volar approach, compared to the dorsal one.

The authors, in this study, found that fracture fixation through volar approach, had good outcomes with respect to bony union, as was found by Bartonicek et al, in a study using VA for exposure of proximal radius, and reported high rates of union without complications.¹²

Kwansy et al studied 80 patients with proximal radius fractures operated by VA. They reported one case of infection and two cases of damage to the sensory branch of radial nerve which recovered. In their study, range of

approach and good coverage on the plate were reported as benefits of the VA.¹³

The anterior or volar approach (VA) described by Henry in 1927,¹⁴ is preferred for biceps repair and boast a distal extensile approach with adequate soft tissue coverage. The PIN may be at risk during this approach and pressure on the nerve during retraction may lead to neurapraxia. In this study, two cases of PIN palsy were observed after VA and 3 cases of PIN palsy through DA. In all the cases motor functions recovered by 6 weeks of surgery. Contrary to the findings of the authors in this study, in another study, Nasab SAM et al, reported a higher incidence of PIN palsy in volar approach, and similar incidences of non-union and infection.¹⁵ Damage to PIN has usually been reported in DA, as was reported in a retrospective study by Peretta DJ et al, who reported 2 cases of PIN palsy following surgery of 11 patients by DA,¹⁶ but incidence after VA indicates that careful attention must be paid during Supinator muscle dissection and retraction.¹⁷ On the other hand, given the changing position of the nerve with forearm movements, care must be taken with precise position of forearm pronation. In this position PIN is parallel to the shaft of Radius and by longitudinal dissection risk of damage to PIN is reduced.¹⁸

Volar approach is standard preferred method for fractures of distal radius, but for proximal half of radius it is controversial.¹⁸ In DA access to bone is easier and dorsal or tension surface of the Radius is in full view, making it more suitable for placement of the plate. However there is possibility of damage to PIN.

In both groups there was no major difference in terms of gender, age or side affected.

CONCLUSIONS

In this study, the results and short-term complications with both VA and DA for surgical treatment of proximal half of Radial diaphysis fractures are similar. Because of the possibility of PIN injury with both the approaches, great care must be taken during surgical dissection of Supinator muscle, and exposure or protection of PIN or both. The expertise, skill and familiarity with the procedure, of the operating surgeon is important for a particular approach. There are studies on either the volar approach or the dorsal one, but a very few studies comparing both the approaches. We tried to compare the outcomes following the two approaches, but more studies with longer follow-up, and multi centric studies may corroborate the findings better.

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