ORIGINAL ARTICLE

OUTCOME OF DYNAMIC COMPRESSION PLATE WITH DORSAL RADIAL SLIDING GRAFT TECHNIQUE FOR WRIST ARTHRODESIS IN BRACHIAL PLEXUS INJURY PATIENTS

Asad Ullah Jan, Tehseen Ahmed Cheema, Sajjad Ahmad*, Muhammad Shafiq, Baqir Hussain*, Farman Ullah***

National Orthopaedic Hospital, Bahawalpur, *Department of Orthopedics and Spine, Hayat Abad Medical Complex, Peshawar, Department of Orthopedics, **Gomal Medical College, DI Khan-Pakistan

Background: The incidence of brachial plexus injuries have shown to increase over the years. It is 1–2% worldwide according to the WHO. In global brachial plexus injuries and lower root injures when the wrist and hand functions are lost, wrist arthrodesis is a viable option. In other cases, when there are some residual hand functions, wrist arthrodesis stabilizes the wrist as well as provides donor muscles tendons to enhance finger functions. Apart from these, wrist arthrodesis increase grip strength and power, and also wrist in extension assume a better shape cosmetically. **Purpose:** Outcome of dynamic compression plate with dorsal radial sliding graft for wrist arthrodesis in terms of time to union and complications in brachial plexus injury patients. **Methods:** This is a retrospective chart review of patients treated in National Orthopaedic Hospital Bahawalpur, from January 2011 to Sep 2017. All the patients with brachial plexopathies of both genders from age 14 to 60 were included in the study. Data was analysed using MS Excel 2010. **Results:** A total of 34 patients were included in the study. Road traffic accidents was the major cause of the injury having 30 (88%) patients whereas birth palsy and gunshots had 2 patients each (6%). Twenty-three patients had no associated fracture while remaining 11 patients had a fracture. There was union in all patients (100 %) and mean time to union was 6.5 weeks (range 6–8) radiologically. Mean follow up was 20.2 months (range 1.5–72).

Keywords: Brachial plexus injury; Wrist arthrodesis; Radius sliding graft; Dynamic compression plate

Citation: Jan AU, Cheema TA, Ahmad S, Shafiq M, Hussain B, Ullah F. Outcome of dynamic compression plate with dorsal radial sliding graft technique for wrist arthrodesis in brachial plexus injury patients. J Ayub Med Coll Abbottabad 2019;31(2): 141–5.

INTRODUCTION

Brachial plexus injuries are not uncommon these days. Brachial plexus injury is a traumatic event that has been shown to increase over the years. Although birth palsy is an important cause, road traffic accidents emerged as the number one cause of adult brachial plexus injuries in the developed world and also in our part of the world. According to the World Health Organization, prevalence of BPI is generally 1–2% worldwide, with the higher numbers being in underdeveloped countries. The incidence of birth related brachial plexus injuries is 0.5–5 infants per 1000 live births in North America. The incidence ranges globally from 0.2 to 4% of live births. The prevalence of adult brachial plexus injuries in North America population is about 1.2%. Brachial plexus injury most commonly affects young healthy adults with 50% of patients between the ages of 19 and 34 years old, and with male patients being 89% at risk.[1–4] Adult brachial plexus injury is a challenge for both the patients and the treating physician. Due to these injuries, suddenly a useful person of a society becomes a burden on society physically as well as financially. For the physician it is quite a challenge to treat such patients. Because the approach is quite comprehensive and multi-dimensional. He has to take into account not only the medical aspect of these injuries but also the psycho-social aspects of the patients.

The management of brachial plexus includes simple watchful waiting for 2–3 months, microsurgical repair, nerve transfers (neurotization), muscles transfers, osteotomies, arthrodesis and advanced procedures like free muscle and nerve transfer.[5,6] In global brachial plexus injuries and lower root injures when the wrist and hand functions are lost, wrist arthrodesis is a viable option. In other cases, when there are some residual hand functions, wrist arthrodesis stabilizes the wrist as well as provides donor muscles to enhance finger functions. These include the powerful wrist flexors (flexor carpi radialis and flexor carpi ulnaris) and wrist extensors (extensor carpi radialis longus and brevious). In brachial plexus injuries the availability of these muscles is a blessing for restoration of basic hand function. Apart from these, wrist arthrodesis increases grip strength and power, and also wrist in extension assume a better shape cosmetically.[7,8]

There are various methods of wrist arthrodesis. These include the classical approach of wrist fusion using iliac crest bone graft and Locking plate, intramedullary rods and pins and the newly introduced method of external fixator and cannulated

screw.[9–15] We have been using small fragment dynamic plate and dorsal radial sliding graft for some time and this is a review outcome of this method in our brachial plexus injury patients.

MATERIAL AND METHODS

This is a retrospective chart review of patients treated in National Orthopaedic Hospital Bahawalpur from January 2011 to Sep 2017. All the patients with brachial plexopathies of both genders from age 14–60 were included in the study. Patients having active infection, previous wrist surgery, and failed wrist fusion as well as children and very old patient with comorbid were excluded from the study. A proforma was designed and all the data was recorded in it. Data was analysed using MS Excel 2010. The surgery was performed by the same surgeon. General anaesthesia was used and tourniquet was applied. Skin was marked on dorsum of hand over the 3rd metacarpal and distal radius. After skin incision, extensor retinaculum was incised between 3rd and 4th extensor compartments. EPL tendon was retracted radially. Joint capsule was removed and articular cartilage of radiocarpal joints and intercarpal joints was removed. A dorsal sliding graft from distal radius was taken which crossed both the joints already debrided. A narrow 9–10 hole, 3.5 mm DCP was bent 15 degrees and applied over the graft with the 3rd metacarpal and distal radius. Wound was closed and below elbow cast of POP was applied. Stiches were removed after 2 weeks and another cast was applied for 4 more weeks. X-rays were taken at 2, 6, 10 weeks and 6 months postoperatively.

RESULTS

A total of 34 patients were included in the study. There were 29 males and 5 female patients. Mean age was 25 years (Range 14–60) and right side was more commonly involved (29 vs. 5).

Road traffic accidents was the major cause of the injury having 30 (88 %) patients whereas birth palsy and gunshots had 2 patients each (6%). Twenty-three patients had no associated fracture while remaining 11 patients had a fracture. Out of these 11 patients having fracture, 8 single bone fracture and 3 multiple bone fractures were present. Radius and ulna were the most commonly injured bone (17.6%) followed by humerus fracture (15.5%) in the whole study group. There was union in all patients (100%) and mean time to union was 6.5 weeks (range 6–8) radiologically. Mean follow up was 20.2 months (range 1.5–72). There were no major complications except one patient where re-fracture of distal radius occurred.

Figure-1: Intra operative images showing dorsal sliding radial bone graft.

Figure-2: Intra operative image showing DCP and post-operative x-rays of wrist arthrodesis

Table-1: Patients Demographics

Pt.No.	Age	Cause	Side	Assoc.#	Sex	Time to union	Follow up	Complications
1	50	RTA	Right	nil	Male	6	19	nil
2	18	RTA	Right	nil	Male	7	20	nil
3	42	RTA	Right	nil	Male	8	20	nil
4	17	BP	Right	nil	Female	8	2	nil
5	60	RTA	right	nil	Male	6	2	nil
6	36	RTA	Right	NOF, R/U	Male	8	18	nil
7	35	RTA	Left	R/U	Male	8	72	nil
8	40	GSW	Right	Humerus	Male	8	52	nil
9	17	RTA	Right	nil	Male	7	52	nil
10	20	RTA	Right	nil	Male	6	52	nil
11	27	RTA	Left	R/U	Male	7	52	nil
12	19	RTA	Right	Humerus, R/U	Male	6	30	nil
13	20	RTA	Right	nil	Male	6	36	nil
14	35	RTA	Right	Humerus	Male	6	1.5	nil
15	23	RTA	Right	nil	Male	6	12	nil
16	23	RTA	Right	R/U	Male	6	7	Refrac radius
17	18	RTA	Right	nil	Male	6	4	nil
18	16	RTA	Right	nil	Female	6	8	nil
19	15	RTA	Right	nil	Male	6	8	nil
20	18	RTA	Right	clavicle	Male	7	4	nil
21	14	BP	Left	nil	Female	7	4	nil
22	16	RTA	Right	Humerus, R/U	Female	6	10	nil
23	22	RTA	Right	nil	Male	6	8	nil
24	24	RTA	Right	Femur	Male	6	5	nil
25	21	RTA	Right	nil	Male	6	9	nil
26	40	RTA	Right	nil	Female	6	9	nil
27	19	RTA	Right	nil	Male	6	36	nil
28	32	RTA	Right	nil	Male	7	12	nil
29	32	RTA	Right	nil	Male	6	18	nil
30	30	RTA	Right	Humerus	Male	6	2	nil
31	20	GSW	Right	nil	Male	7	20	nil
32	38	RTA	Left	nil	Male	6	18	nil
33	45	RTA	Right	nil	Male	6	18	nil
34	16	RTA	Left	nil	Male	6	20	nil

DISCUSSION

There are various indications of wrist arthrodesis and remain the treatment of choice in some of these. These include Rheumatoid arthritis, post traumatic wrist arthritis, post tumour reconstruction or as a salvage procedure in failed limited wrist arthrodesis or wrist arthroplasty.[16,17] But the most important indication of wrist arthrodesis are pan-plexus brachial plexus injuries, spastic hemiplegia or cerebral palsy patients. In global brachial plexus injuries and lower root injures when the wrist and hand functions are lost, wrist arthrodesis is a viable option. There are many advantages of wrist fusion. It provides spare wrist muscles for finger motion. The hand looks better in extended position and the grip strength and power is increased.[7,8]

There are various techniques of wrist arthrodesis. These include the wrist fusion using iliac crest bone graft and Locking plate, intramedullary rods and pins, external fixator and cannulated screw and k-wire followed by cast immobilization.[9–15] Initially studies were conducted to know the outcomes of carpometacarpal joints inclusion in the wrist fusion. The results of Nagy and Buchler comparative study were quite conclusive, as 47 wrist arthrodesis that included the carpometacarpal joints in the fusion, 20 evolved with pseudo-arthrosis and 11 of these were painful, requiring additional surgery while in the other group without carpometacarpal inclusion of 34 cases, only one evolved with pain and re-operation.[18]

Wrist fusion using dorsal plate and iliac crest bone graft is considered to be the gold standard. The wrist was placed in 15–20 degrees of extension in this study; the extension position is suggested by most authors offering better functional outcomes.[19,20] Autogenous iliac crest graft is added because the bone is already osteopenic and cancellous bone graft adds to the healing potential of fusion.

Reigstad and Holm-Glad followed 11 patients with wrist arthrodesis for six years after failed wrist arthroplasties. Iliac crest cancellous graft was used with a dorsal plate. Bone union was achieved in all the patients clinically and radiologically. There was substantial reduction in pain and improvement in daily function as well as grip strength compared with those before arthrodesis.[21] Similarly, De Smet and Truyen used dorsal plate and cancellous bone graft in 36 degenerative or post traumatic osteoarthritis patients. The follow up was of 4 years' duration. The union rate was also high and immobilization was minimal. However, there were numerous complications in both the studies, varying from minor transient problems to wound infection, extensor tendon adhesions, carpal

tunnel syndrome, plate loosening or breakage and dystrophy that often necessitated secondary operations.[22]

In other study 24 brachial plexus injuries patient had wrist arthrodesis using dorsal plate and iliac crest bone graft. There was 100% union rate with 1 post-arthrodesis complication. One patient required wrist fusion plate removal because of painful hardware.[23] Similarly, 97 brachial plexus patients operated between 1978 and 2006, charts were reviewed. Among these, 61 had wrist fusion using iliac crest bone graft and a dorsal plate. There was 100 percent fusion and the patients were satisfied from the procedure for stability, cosmesis and function using DASH and Terzis questionnaires.[24]

The common denominator in all the studies mentioned above is the use of autogenous iliac bone graft. Bone graft harvesting from the iliac crest along with numerous advantages carry significant risk of morbidity. It is another surgical procedure and thereby increasing time of original surgery. It has major complication like deep wound infection, hernia, iliac bone fracture and chronic pain compromising gait and daily activity. The overall complication rate ranges from 9 to 49%.[25] The most common complication is donor site pain. In studies it is noted that donor site pain is present in 50 percent of the patients in the first month post-operatively and this pain can prolong up to 6 months.[26]

In our study, union rate is comparable to the above studies having mean duration of union of 6.5 weeks. The mean follow-up was of 20.2 months (range 1.5–72). There was major complication in only 1 patient. He had radius fracture at the time of brachial plexus injury and it was fixed with volar plate. When we performed the wrist fusion, there was not enough space for the dorsal plate as the volar plate screws were abutting the dorsal plate. As there was union of radius fracture, we removed the volar plate and applied the dorsal plate but re-fracture occurred at the previous injury site. Again fracture was fixed and a long plate was applied volarly, so radius had double plating.

The dorsal sliding bone graft has the added advantage of no additional procedure, sparing the patients of unwanted complications.

CONCLUSIONS

Wrist arthrodesis in brachial plexus patients gives wrist stability and improves aesthetic appearance of hand. In addition, carpus fusion enhances finger function by muscle and tendon transfer and patient satisfaction with procedure. The efficacy of wrist fusion using sliding distal radius graft in achieving union is comparable to iliac crest bone graft without the downtime of donor site morbidity, and it should be recommended as basic technique for wrist fusion in plexopathies patients.

AUTHORS' CONTRIBUTION

AJ: Literature search, data collection. TAC: Concept of study design. SA: Data analysis. MS: Data interpretation. BA: Proof reading. FU: Write-up

REFERENCES

1. Smania N, Berto G, La Marchina E, Melotti C, Midiri A, Roncari L, *et al*. Rehabilitation of brachial plexus injuries in adults and children. Eur J Phys Rehabil Med 2012;48(3):483–506.
2. Dubuisson AS, Kline DG. Brachial Plexus Injury: A Survey of 100 Consecutive Cases from a Single Service. Neurosurgery 2002;51(3):682–3.
3. Gilbert W, Nesbitt TS, Danielsen B. Associated factors in 1611 cases of brachial plexus injury. Obstet Gynecol 1999;93(4):536–40.
4. Ecker J, Greenberg JA, Norwitz ER, Nadel AS, Repke JT. Birth Weight as a Predictor of Brachial Plexus Injury. Obstet Gynecol 1997;89(5):643–7.
5. Ruhmann O, Schmolke S, Bohnsack M, Carls J, Flamme C, Wirth CJ. Reconstructive operations for the upper limb after brachial plexus palsy. Am J Orthop (Belle Mead NJ) 2004;33(7):351–62.
6. Soucacos PN, Vekris MD, Zoubos AB, Johnson EO. Secondary reanimation procedures in late obstetrical brachial plexus palsy patients. Microsurgery 2006;26(4):343–51.
7. Solem H, Berg NJ, Finsen V. Long term results of arthrodesis of the wrist: a 6-15 year follow up of 35 patients. Scand J Plast Reconstr Surg Hand Surg 2006;40(3):175–8.
8. Rauhaniemi J, Tiusanen H, Sipola E. Total wrist fusion: a study of 115 patients. J Hand Surg Br 2005;30(2):217–9.
9. Hazewinkel J. Arthrodesis of the radiocarpal joint. J Int Coll Surg 1962;38:137–40.
10. Mannerfelt L, Malmsten M. Arthrodesis of the wrist in rheumatoid arthritis. A technique without external fixation. Scand J Plast Reconstr Surg 1971;5(2):124–30.
11. Benkeddache Y, Gottesman H, Fourrier P. Multiple stapling for wrist arthrodesis in the nonrheumatoid patient. J Hand Surg Am 1984;9(2):256–60.
12. Meads BM, Scougall PJ, Hargreaves IC. Wrist arthrodesis using a Synthes wrist fusion plate. J Hand Surg Br 2003;28(6):571–4.
13. Voutilainen NH, Patiala HV, Juutilainen TJ, Rokkanen PU. Long-term results of wrist arthrodeses fixed with self-reinforcedpolylevolactic acid implants in patients with rheumatoid arthritis. Scand J Rheumatol 2001;30(3):149–53.
14. Houshian S, Schroder HA. Wrist arthrodesis with the AO titanium wrist fusion plate: a consecutive series of 42 cases. J Hand Surg Br 2001;26(4):355–9.
15. Vekris MD, Pakos EE, Soucacos PN, Gavriilidis I, Beris AE. Wrist arthrodesis for brachial plexus palsy using an external fixator and a cannulated screw (Ioannina technique). J Orthop Surg (Hong Kong) 2010;18(1):87–91.
16. Jebson PJ, Adams BD. Wrist arthrodesis: review of current technique. J Am Acad Orthop Surg 2001;9(1):53–60.
17. Thom H, Manolikakis G. Results of hand surgery operations in spastic-athetotic paresis. Z Orthop Ihre Grenzgeb 1988;126(3):274–81.
18. Nagy L, Buchler U. AO wrist arthrodesis: with and without arthrodesis of thethird carpometacarpal joint. J Hand Surg Am 2002;27(6):940–7.
19. Hastings H. Wrist arthrodesis. In: Green PD, Hotchkins NR, Pederson CW, editors. Green's Operative Hand Surgery. Vol. 1, 4th ed. New York: Churchill Livingstone, 1999; p.131–46.

20. Garcia-Elias M, Cooney PW. Kinematics of the radiocarpal joint. In: Cooney WP, Linscheid RL, Dobyns JH, editors. The wrist: diagnosis and operative treatment. Mosby, 1998; p.106–23.
21. Reigstad O, Holm-Glad T, Thorkildsen R, Grimsgaard C, Røkkum M. Successful conversion of wrist prosthesis to arthrodesis in 11 patients. J Hand Surg Eur Vol 2017;42(1):84–9.
22. De Smet L, Truyen J. Arthrodesis of the wrist for osteoarthritis: outcome with a minimum follow-up of 4 years. J Hand Surg Br 2003;28(6):575–7.
23. Giuffre JL, Bishop AT, Spinner RJ, Kircher MF, Shin AY. Wrist, First Carpometacarpal Joint, and Thumb Interphalangeal Joint Arthrodesis in Patients with Brachial Plexus Injuries. J Hand Surg 2012;37(12):2557–63.
24. Terzis JK, Barmpitsioti A. Wrist Fusion in Posttraumatic Brachial Plexus Palsy. Plast Reconstr Surg 2009;124(6):2027–39.
25. Makridis KG, Ahmad MA, Kanakaris NK, Fragkakis EM, Giannoudis PV. Reconstruction of iliac crest with bovine cancellous allograft after bone graft harvest for symphysis pubis arthrodesis. Int Orthop 2012;36(8):1701–7.
26. Matsa S, Murugan S, Kannadasan K. Evaluation of morbidity associated with iliac crest harvest for alveolar cleft bone grafting. J Maxillofac Oral Surg 2012;11(1):91–5.

Submitted: 17 February, 2018	*Revised: --*	*Accepted: 30 December, 2018*

Address for Correspondence:

Asad Ullah Jan, Postal address. House No 20-A, Street No 5, Professor Colony, University Campus, Peshawar-Pakistan
Cell: +92 332 906 1961
Email: asadjankmcb@gmail.com