

CURRENT RESEARCH AT THE MGH ORTHOPAEDIC HAND SURGERY SERVICE: NEW TECHNOLOGIES FOR THE TREATMENT OF TRAUMA SEQUELAE IN THE ELDERLY PATIENT

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INTRODUCTION

The use and development of new technologies has been a hallmark of our Hand Service. As an example we will present our utilization of newly-designed angular stable plates with Norian bone cement to improve our ability to surgically correct distal radius malunions in the elderly.

Union with deformity is the most common complication following a distal radius fracture.(1) This deformity can be intra-articular, affecting either the radiocarpal or radioulnar joints; extra-articular characterized by metaphyseal angulation and loss of length, or it may be a combination of both.(2-6)

Corrective osteotomies have been proven to be an effective treatment for symptomatic malunion.(1, 7)

A variety of techniques have been used, however there has remained concern regarding the indications for surgical intervention in the presence of underlying osteoporosis as well as the recognized morbidity associated with autogenous iliac crest bone grafting.(8-10)

Technical advances including the use of precontoured internal fixation devices with angular stable fixation, as well as the use of osteointegration biomaterials have offered some advantages.

The former facilitates osteosynthesis characterized by higher stability even in osteopenic bone and in altered bone architecture as it is seen in osteoporosis.(11-17) These implants afford osseous fixation that allows early motion and rehabilitation.(18) Also their precontoured shape maintains desirable patterns of alignment, congruency and inclination of the distal radius after corrective osteotomy because of their ability to ensure angular and axial stability.(18-20) These properties reduce the probabilities of screw loosening and consequent loss of reduction.(4, 20)

Following osteotomy and achievement of proper angulation and alignment, there will exist a three-dimensional defect that must be filled in order to adequately support the bone fragments.(21-25)

Autogenous bone grafts have been widely used for this purpose. They have a recognized potential for donor site morbidity, in particular those involving corticocancellous variants.(8, 10, 26) Materials such as polymethylmethacrylate (PMMA) and osteoconductive biomaterials such as Norian Skeletal Repair System (Norian SRS)® offer structural support eliminating effects of donor site morbidity.(21-25) Experience with polymethylmethacrylate (PMMA) has shown lack of osseous integration.(24, 25) In contrast, prospective randomized trials demonstrated good clinical and radiological results with osteoconductive synthetic materials such as Norian SRS®.(21-25)

Case	Gender	Age	Occupation	Hand Dominance	Involved Hand	Mechanism of Injury
1	F	51	Disabled	R	R	Self height fall
2	M	44	Nurse Manager	R	R	Fall while skating
3	F	46	Jeweler	R	L	MVC Polytrauma
4	F	48	Nurse	R	L	Self height fall
5	M	60	Real State Developer	R	R	Fall walking on Ice
6	F	55	Legal Assistant	R	R	High height fall
7	F	74	Supervisor department store	R	R	High height fall
8	M	60	Retired Arts teacher	R	R	Assaulted
9	F	55	?	R	R	MVC Polytrauma
10	F	56	Software Engineering	R	L	MVC Polytrauma
11	M	53	Manager	R	L	High height fall

Table 1: Demographic Series Information.

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We believe this operative technique to be safe and predictable. Additional benefits such as the use in osteoporotic patients and the elimination of donor site morbidity also support the practice of this technique.

INDICATION FOR THIS SURGICAL TECHNIQUE

We consider this technique indicated and ideal in the elderly patient, who is experiencing symptoms and disability caused by a malunion of a previous distal radius fracture. This surgery is appropriate to treat these patients, whose bone quality is not adequate to tolerate any type of implant due to the presence of osteopenia or osteoporosis.

MATERIALS AND METHODS

Between 2002 and 2004, 11 patients, 7 female and 4 male with an average age of 55 years (range: 44 to 74 years), were treated at Massachusetts General Hospital, Orthopaedic Hand Surgery Service by a single orthopaedic hand surgeon (J.B.J.) (Table 1)



Figure 1: Pre operative Dorsal deformity of a patient with distal radius malunion. Post operative status showing the correction of the dorsal deformity with stable angle implants and Norian cement.



Figure 2: Pre operative Volar deformity of a patient with distal radius malunion. Post operative status showing the correction of the Volar deformity with stable angle implants and Norian cement.

The patients presented at 8 months post trauma (range: 1 to 14 months) with symptomatic distal radius malunion. Preoperative clinical and radiological evaluations were done to assess range of motion, grip and pinch strength and characterize radiologically the malunion.

Four patients were classified as “Dorsal” malunion. This pattern was typified as severe dorsal tilt of the radius in the lateral plane. (Fig 1) The physical exam of these patients consistently presented excessive wrist extension and lack or impairment of wrist flexion. Seven patients were classified as “Volar” malunion. These were characterized as deformities with marked volar tilt of the distal radius on the pre-operative radiography lateral view. (Fig 2) In contrast, these patients had

a lack of wrist extension and greater wrist flexion when compared to the opposite limb).

The osteotomy was performed through dorsal approach in four patients and via volar approach in five; two had a combined approach due to excision of previously placed internal fixation as well as the need for median nerve decompression. Two corrections included an intraarticular osteotomy.

All cases were performed under regional block anesthesia. For internal fixation five patients were treated with volar locking 2.4 mm T plates and six with dorsal 2.4 mm. T, L and/or radial column locking plates. Following the osteotomy and internal fixation, the created defect was filled with Norian SRS cement®. X-rays were taken to evaluate quality of reduction and fixation after the osteotomy. At 10 to 14 days of postoperative immobilization, all patients started active motion exercises.

Pre and postoperative range of motion and grip strength were measured by an independent observer. Wrist and forearm mobility were objectively quantified with a goniometer (Orthofix, USA). Excellent range of motion was defined as 100% of wrist and forearm motion of the contralateral limb. Good results as between 75% and 99%; fair between 50% and 74% and bad when achieved motion was less than 50% of the uninvolved limb. Grip strength was tested also pre and post-operatively, using a hydraulic hand dynamometer (Baseline® FEI, Irvington, N.Y. 10533, USA) with the elbow set at the third station (elbow at ninety degrees of flexion and the wrist and forearm in neutral). Postoperatively, all patients were measured according to the Modified Mayo wrist score and the modified Gartland and Werley score to evaluate outcomes in terms of pain, ability to return to work, mobility, grip strength, residual deformities and complications. The DASH questionnaire was also completed at the postoperative visit.

Ulnar inclination, volar tilt, radial length and ulnar variance were measured in pre and postoperative radiographs according to the standard technique for radiographic measurement in the radius. Percentage improvement and averages were calculated for each patient.

RESULTS

Corrective osteotomies were performed an average of 8 months after the initial injury (range: 1 – 14 months). There were no perioperative complications. All osteotomies healed. At an average follow up of 17 months (range: 6 to 22), 8 patients of the 11 have completed the evaluation. An average wrist and forearm motion of 78% of the opposite side was achieved. Average achieved wrist and forearm motion was 47° degrees of flexion, 43° of extension, 75° of supination, 86° of pronation, 20° of radial deviation and 35° of ulnar deviation.

The Modified Mayo wrist score scale was used to measure grip strength. The total of 8 patients were rated as good strength (strength between 75% and 99%). The grip strength on average was 88% when compared to the uninvolved hand. The average grip was 69.8 pounds.

According to the Modified Mayo Wrist Score, two patients rated as good result (75-89pts) and six as a fair outcome (50-74pts). There were no patients scoring a bad result (less than

Case	Follow Up (months)	Complications	MMS*	MMS* Benchmarks	GW**	GW** Benchmarks	DASH
2	22	None	85	Good	1	Excellent	0
4	14	None	75	Fair	4	Good	6
5	14	None	65	Fair	15	Fair	29
6	16	None	65	Fair	9	Fair	41
7	32	None	65	Fair	18	Fair	26
8	22	None	65	Fair	8	Good	38
10	6	None	70	Fair	5	Good	17
11	6	None	80	Good	3	Good	15

Table 2:
Functional Series
Outcome after
Corrective Osteotomy
with Angle Fixed
Implants and Norian
Cement.

*Modified Mayo Score **Modified Gartland and Werley Score.

50pts). The average Modified Mayo Wrist Score was 71 points of a hundred (range: 65-85).(Table 2)

When using the Modified Gartland and Werley Score, one patient rated as excellent outcome (0-2pts.); four as good results (3-8pts); and three as a fair result (9-20pts). There were no poor results (more than 21 pts). The average Gartland and Werley score was 7.8 points, ranging from 1 to 18 points. (Table 2)

The average DASH score was 21.5 points, ranging from 0 to 41. (Table 2)

One patient required a Darrach's procedure at 6 months to increase motion and management of pain at the distal radio ulnar joint. Two patients required plate removal due to pain and limitation in movement. These patients have not completed their final follow up.

In terms of X ray evaluation the average pre operative volar tilt was 19.4° in extension in the dorsal deformity group and 25° in flexion in the volar deformity group. Postoperatively, the average palmar tilt was 12.9° in the former and 12.5° in the latter group. The average improvement after surgery was 24.6° degrees in patients with dorsal deformity and 14.1° in those with volar deformity. Pre operative ulnar variance was on average 4.1 mm, after surgery it corrected to 2.54 mm (50%). Ulnar inclination averaged 14.5° preoperatively, after treatment it averaged 22° presenting an improvement of 7.5°. Lastly, with the exception of one patient, restoration after surgery achieved acceptable clinical outcomes and radiologic parameters. Assessment for posttraumatic arthritis was negative in every case at the time of follow up.

DISCUSSION

A corrective osteotomy in the older patient is more difficult because of the associated osteopenia as well as the limited autogenous bone graft to be obtained from the iliac crest. Several technological advances have made this procedure more predictable. The first is the development of low profile implants with angular stable screw fixation. This osteosynthesis system device has shown good results in maxillofacial and spine surgery, where stability is required without bicortical screw purchase.(13, 16, 17)

The locking compression system offers a similar mechanism of action with the mechanical advantage of multiple

points of screw fixation when compared to fixed angle devices. It is a point of crucial importance in fractures with long working lengths, short periarticular fragments and the absence of osseous support on the contralateral side where the plate is placed.(13) The angle fixed constructs do not affect the blood supply to the bone and do not require good bone quality to proportionate stability. In this system, threads on the screw heads lock into the corresponding threads on the screw hole of the plate, eliminating therefore toggling. Forces are transmitted then from the bone to the plate across the threaded connection converting compression unnecessary to get stability. This lack of compression preserves the blood supply to the bone improving conditions for healing. Disadvantages of this system include no tactile feedback to the surgeon while tightening the screws. Previous reduction is needed before application of the device, once the locked screw is placed below or above of the fracture site no further reduction is possible unless the construct is totally removed.(27-30) Clinical trials have verified the efficacy of fixed angled plates for the treatment of distal radius fractures. (27-30) Functional outcomes are promising and the rate of complications low, making this implant desirable also for the stabilization of osteotomies for the treatment of distal radius malunion.

The second technical advance is the use of cement and biomaterials that can support and put together fragments of bone, and that can fill defects after severe comminution or osteotomies. The role of this material is particularly important in osteoporotic bone that cannot tolerate adequately constructs and that needs support while consolidation process takes place. Norian SRS Cement offers biocompatibility and osteointegration; high compressive strength, even higher than cancellous bone; fast-setting that cures in vivo at physiological pH and temperature avoiding local damage tissue characteristic of PMMC use; and lastly injectable consistency that allows percutaneous as well as open-technique application.(24)

Additionally, advantages in imaging under fluoroscopy and X rays have been proved.(9, 31)

Two prospective randomized studies (Sanchez-Sotelo et al and Cassidy et al) evaluating the use of Norian showed good results.(21, 24) Clinical outcomes were significantly better than the standard care; however, none of them defined what

type of fractures gets benefit from this particular approach with cement and percutaneous fixation. Recent research has demonstrated comparable results between percutaneous fixation and open reduction and internal fixation for extra articular and non-complex intraarticular fractures(30), therefore, the role of Norian® cement in distal radius fractures in previous studies must be related with bone quality, in other words, osteoporosis and osteopenia.

According to the mechanism of action and previous description of these two surgical advances, we consider them extremely useful for the treatment of malunions in osteopenic patients that suffered a distal radius fracture concluding in malunion or mal-alignment. We find this technique useful and safe to treat malunion.

CONCLUSION

This series reports the results of treatment of distal radius malunion with osteotomy plus internal fixation with locking compression plates and Norian SRS®. Our purpose is to present this technique as an alternative in these complex cases where we have to face the elderly patient with osteoporotic bone.

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