

Treatment of Volar Barton's Fractures: Comparison between Two Common Surgical Techniques

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Background: Volar Barton's fractures are not uncommon but more convincing treatment methods are still controversial. Currently, open reduction with buttress plating or closed reduction with external fixation and percutaneous Kirschner wire fixation have achieved most support.

Methods: Twenty-three consecutive volar Barton's fractures treated with either open reduction and buttress plate fixation (12 cases) or closed reduction with external fixation and percutaneous Kirschner wire fixation (11 cases) were compared retrospectively. The fractures were followed-up for a mean of 30 months (range, 24-50 months).

Results: All 23 fractures healed without major complications. The wrist function was satisfactory in all plating patients (12 out of 12) and nine out of 11 external fixation patients ($p = 0.22$).

Conclusion: Both the above mentioned surgical techniques give a high success rate. Despite the fact that each technique has advantages and disadvantages, the results from the plating treatment seem to be superior.
(*Chang Gung Med J* 2006;29:388-94)

Key words: volar Barton's fracture, buttress plate, external fixation, Kirschner wire.

Volar Barton's fractures are not uncommon and may be due to either high or low energy injuries.^(1,2) Such fractures are unstable and methods of treatment vary.^(3,4) Although different success rates have been reported for non-surgical and surgical techniques in the literature, surgical treatment is currently favored.^(4,5)

Various surgical techniques have been reported in the literature. Currently, closed reduction with external fixation and percutaneous Kirschner pinning or open reduction with volar buttress plating have achieved most support.⁽⁴⁻⁶⁾ Articles reporting surgical treatment for volar Barton's fractures are numerous

but concomitant comparison of both described techniques are few. The purpose of this retrospective study was to compare these two surgical techniques and recommend the best method.

METHODS

From January 1996 to December 2001, 762 consecutive adult patients (>16 years) with isolated distal radial fractures (not combined with distal ulnar fractures) were treated at the Chang Gung Memorial Hospital in Keelung. Twenty-three fractures (3.0%) were volar Barton's fractures (AO type B3.2 and

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Received: Nov. 15, 2005; Accepted: May 1, 2006

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B3.3, intra-articular involvement with a volar fragment and volar subluxation of the carpus) and were included in this study.^(5,6) Patients were aged from 18 to 72 years (median, 39 years) with a male to female ratio of two to one.

The causes of fracture included 13 motorcycle accidents, five tripping over, three sports injuries and two falls from a height. Twenty-two fractures were closed and one was an open type I fracture.⁽⁷⁾ Fourteen fractures were in the dominant limb. Associated injuries consisted of three polytrauma and two ipsilateral humeral shaft fractures.

At the emergency department, the patients' vital signs were first stabilized and then a systemic examination was performed. Volar Barton's fractures were treated as early as possible, usually within six to 48 hours (mean, 18 hours). The favored treatment method depended upon the surgeon's individual opinion. As all these fractures were treated within 48 hours, closed reduction was not difficult and the comparison of functional recovery of the wrist was less affected.

Surgical technique

For patients undergoing pinning treatment, general anesthesia with endotracheal intubation was performed. Finger trap traction was applied to the thumb. Using forceful manipulation, the displaced volar fragment was pushed back. After the fragment was reduced (< 2 mm articular step-off in comminuted fractures) and was confirmed using an image intensifier, a 2.0 mm Kirschner wire (Mizuno, Tokyo, Japan) was inserted from the radial styloid process to the ulnar side of the proximal cortex with a power hand-tool. The pin end was bent and kept outside the skin. The fragment reduction was rechecked using the image intensifier. An external fixator (Trauma-Fix, Trend Medical Inc., San Leandro, CA, USA) was applied to bridge the wrist joint and enforce wrist stability.

For patients undergoing plating treatment, general anesthesia with endotracheal intubation was performed. The Ellis approach was used and the wrist joint was opened at the volar aspect.⁽⁸⁾ A dissection plane between the flexor carpi radialis and the palmaris longus was developed. The radial artery was retracted radially and the median nerve ulnarly. The fibers of the pronator quadratus were severed from their origin on the radius. The fragments were

reduced with a periosteum elevator under direct vision and a buttress plate (Synthes, Bettlach, Switzerland) was applied to the volar aspect of the radius. The plate had to be bent about 10- degrees, tilting volarly. After the wound was closed with absorbable sutures, a short arm splint was applied. The hand was kept in a position of ulnar deviation and slight flexion.

For the two patients with associated humeral shaft fractures, the Barton's fractures were treated with plating and the humeral fractures were treated with U-slab splints first. After two weeks, the splint was removed and a functional brace was applied until the fracture was healed. The external fixation with Kirschner wire or short arm splint was removed after six weeks. Active wrist range-of-motion exercises were encouraged. Progressive heavy loading of the wrist was permitted. Patients were followed-up at the Outpatient Department after six weeks, three months, one year and whenever necessary. The bony and the radiographical healing processes were recorded. The wrist function was evaluated with Pattee and Thompson criteria, and a satisfactory outcome included an excellent or good grade.⁽³⁾ An excellent result had no pain, no disability and no more than 5° loss of wrist flexion or extension; a good result had occasional mild pain, no disability and 15° or less loss of wrist flexion or extension; fair results had mild to moderate pain, modification of certain activities, continued employment at the pre-injury occupation and 25° or less loss of motion; and poor results had severe pain, residual disability requiring occupation change and more than 25° loss of motion.

For statistic analysis, the Fisher's exact test, the Mann-Whitney U test and the Wilcoxon signed rank test were used. Significant statistical difference was set at $p = < 0.05$. The repeated two-factor ANOVA test was also applied because the values included between-subject factors (group, two levels: plating and pinning) and within-subject factors (time, two levels: post-op and follow-up).

A fracture union was clinically defined as no pain or tenderness during daily activity with loading, and radiographically defined when trabeculae had bridged the main fracture fragments.⁽⁹⁾ Nonunion was defined as a fracture that was still not united after one year's treatment.⁽¹⁰⁾

RESULTS

The mean follow-up period was 30 months (range, 24-50 months). Twelve fractures were treated with plating and 11 with pinning. All fractures healed within three months and the union rate was 100% (Figs. 1 and 2; Table 1). There were no perioperative complications. There were no cases of failed closed pinning that needed to be converted to plating.

Postoperatively, the mean radioulnar variance (the ulnar prominence of the distal radioulnar joint) in the plating group was minus 1.3 mm (range, minus 3 ~ plus 1 mm) and in the pinning group was minus 0.9 mm (range, minus 2 mm ~ plus 2 mm). At the latest follow-up, the mean radioulnar variance in the plating group was minus 1.0 mm (range, minus 3 ~ plus 2 mm; $p = 0.08$) and in the pinning group was minus 0.6 mm (range, minus 2 mm ~ plus 3 mm; $p = 0.08$). The comparison between both techniques was not significant ($p = 0.59$). Postoperatively, the mean volar inclination (the volar tilting of the distal radial joint) in the plating group was plus 5.3 degrees (range, 0 ~ plus 10 degrees) and in the pinning group

was plus 5.7 degrees (range, plus 1 ~ plus 10 degrees). At the latest follow-up, the mean volar inclination in the plating group was plus 5.1 degrees (range, minus 1 ~ plus 10 degrees; $p = 0.08$) and in the pinning group was plus 5.3 degrees (range, minus 2 ~ plus 10 degrees; $p = 0.14$). The comparison between both techniques was not significant ($p = 0.89$). Postoperatively, the mean ulnar angulation (the inclination of the distal radial joint) in the plating group was 19.6 degrees (range, 15 ~ 24 degrees) and in the pinning group was 17.9 degrees (range, 15 ~ 22 degrees). At the latest follow-up, the mean ulnar angulation in the plating group was 19.0 degrees (range, 12 ~ 25 degrees; $p = 0.11$) and in the pinning group was 17.5 degrees (range, 14 ~ 22 degrees; $p = 0.10$). The comparison between both techniques was not significant ($p = 0.28$).^(5,6) The repeated two-factor ANOVA tests were $p = 0.91, 0.92$ and 0.83 , respectively.

There was no superficial or deep wound infection, nonunion or malunion (> 2 mm step-off of the joint surface, > 5 mm of radioulnar variance, > 10 degrees of dorsal inclination, < 10 degrees of ulnar angulation).⁽¹¹⁾

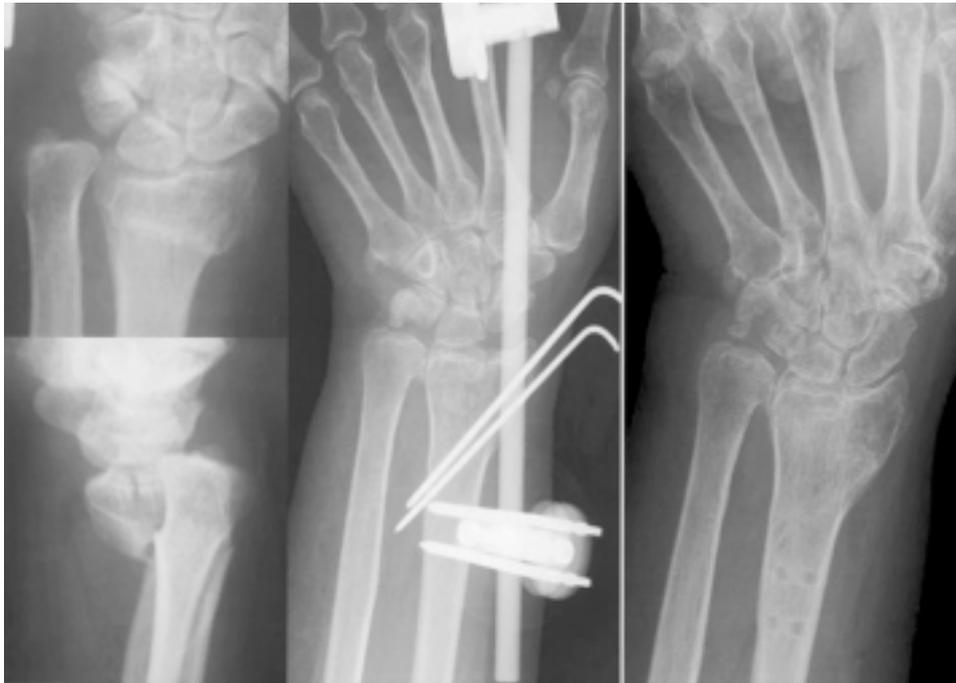


Fig. 1 A 48-year-old man sustained a right volar Barton's fracture due to a motorcycle accident. The fracture was treated with closed reduction, percutaneous Kirschner wire fixation and external fixation. The fracture healed uneventfully and wrist function was excellent.



Fig. 2 A 37-year-old man sustained a left volar Barton's fracture due to a motorcycle accident. The fracture was treated with open reduction and buttress plate fixation. The fracture healed uneventfully and wrist function was excellent.

Table 1. Comparison of Radiographical Features of Both Techniques

Item	Plating (n = 12) Mean (Range)	Pinning (n = 11) Mean (Range)	p value
Radioulnar variance			
Post-op	-1.3 (-3 ~ +1) mm	-0.9 (-2 ~ +2) mm	0.55
Follow-up	-1.0 (-3 ~ +2) mm	-0.6 (-2 ~ +3) mm	0.59
p value	0.08	0.08	
Volar inclination			
Post-op	+5.3 (0 ~ +10) degrees	+5.7 (+1 ~ +10) degrees	0.75
Follow-up	+5.1 (-1 ~ +10) degrees	+5.3 (-2 ~ +10) degrees	0.89
p value	0.08	0.14	
Ulnar angulation			
Post-op	19.6 (15 ~ 24) degrees	17.9 (15 ~ 22) degrees	0.14
Follow-up	19.0 (12 ~ 25) degrees	17.5 (14 ~ 22) degrees	0.28
p value	0.11	0.10	

At the latest follow-up, the functional outcome of the wrist revealed that a satisfactory result was achieved in 12 plating and nine pinning patients ($p = 0.22$). This was a retrospective study. The comparison at a certain time point was not designed prospec-

tively. However, the minimal follow-up was two years. The comparison might be acceptable. On the plain radiographs, three patients had sustained mild radiocarpal arthrosis and all occurred in the pinning group ($p = 0.09$).⁽⁵⁾ Two of the three patients had fair functional outcome and the third had a good outcome.

DISCUSSION

Factors favoring fracture healing include minimal gap, adequate stability and sufficient nutrition supply.⁽¹²⁾ For the distal radius, massive cancellous bone can speed the fracture healing process. Therefore, a nonunion at this area is rare. On the other hand, malunion is not uncommon; volar Barton's fractures often produce volar subluxation of the carpus.^(5,6) The principle of treatment is mainly to provide anatomic reduction and stabilization.⁽⁵⁾

A malunion of a volar Barton's fracture can cause serious disability, which is very complicated to treatment. Additionally, the articular cartilage may be severely injured and cannot regenerate.^(13,14)

Therefore, prevention of a malunited volar Barton's fracture is extremely important to avoid having to treat a malunion. In this study, plating or external fixation combined with Kirschner pinning achieved sufficient stability during the fracture healing process. In other words, both techniques provide sufficient stability for the healing process to occur. However, in the literature, the stability of an external fixation is doubted.⁽¹⁰⁾ This is contrary to the present study. Improved surgical technique may explain this difference.

Clinically, both techniques have advantages and disadvantages. Plating treatment can reduce fragments more precisely and the fragments can be stabilized more securely.^(5,6) However, it requires opening the fracture site. If local swelling is serious, closure of the incision site may be very difficult, although the incision is usually not large and the infection rate negligible. Additionally, the fracture healing process is not hindered due to the cancellous bone character. The success rate is therefore high.

Pinning treatment avoids opening the fracture site and so there is no need to worry about incision site problems. However, fragment reduction with stabilization may be not so satisfactory. Moreover, tendon penetration by the external fixation may interfere with thumb and index finger movement.^(16,17) Fortunately, the external fixation can usually be removed after six weeks, and wrist and finger range-of-motion exercises can then be implemented. Therefore, the functional outcome of the wrist joint is largely satisfactory.

In the literature, the satisfaction rating with volar plating is 77~94%.⁽³⁻⁶⁾ However, in the present series, all 12 fractures achieved satisfactory results (100%). Long-term results mainly depend upon the degree of arthrosis of the wrist as volar Barton's fractures involve the articular surface and the injured articular cartilage normally cannot regenerate.^(13,14) Therefore, the longer the follow-up, the lower the success rate. In the present series, the mean follow-up period was 2.5 years and in the reported articles longer follow-up was undertaken.⁽³⁻⁶⁾ On the other hand, the wrist is not a weight-bearing joint and its deterioration should be very slow. Therefore, the satisfaction rating will reduce only gradually over time.

In the literature, there are many reports about closed reduction and external fixation with percutaneous pinning of the volar fragments. The success

rate is 80~92%.^(18,19) The unsatisfactory cases are due to restriction of thumb and index finger movement. Despite the fact that external fixation and Kirschner wires are removed within six weeks, some patients still cannot flex their fingers effectively. Accordingly, external fixation pins must be placed carefully. The success rate will then be raised.

Closed reduction of the intraarticular fragments can be assisted by arthroscopy or use of an image intensifier.^(18,21) These techniques have advantages and disadvantages. In the literature, arthroscopy-assisted reduction is reported to be superior to use of an image intensifier due to more precise guidance.^(20,21) Practically, using arthroscopy requires a period of training and surgeons are not always familiar with this technique. However, closed reduction under image intensifier guidance needs no high-tech knowledge. As a result, most surgeons still use an image intensifier when closed reduction is performed.^(18,19)

To avoid poor function of the joints, wrist and finger range-of-motion exercises should be implemented as early as possible. This is especially important for Barton's fractures that have intraarticular involvement. Once adhesion in the joint occurs, treatment becomes very complicated. Both intra- and extra-articular release techniques are very difficult. In the present series, immobilization of the joints lasted no more than six weeks. This may be another factor that influenced the high satisfaction rating.

In conclusion, volar Barton's fractures are not uncommon. Current surgical techniques can provide a high satisfaction rating. In the present study, both open reduction with buttress plate stabilization, and closed reduction with pinning and external fixation stabilization can achieve a high success rate. Both techniques have advantages and disadvantages but the results from the plating treatment seem to be superior.⁽²²⁾

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治療掌側巴頓氏骨折：兩種常用手術方法的比較

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背景：掌側巴頓氏骨折並非不常見，但最使人信服的治療方法仍有爭論。當前情況，以開放式復位並以鋼板固定，或以閉鎖式復位，並以外固定架及經皮鋼釘固定的手術方法，最受人支持。

方法：23 個連續性的掌側巴頓氏骨折，12 個以開放式復位並以鋼板固定；另外 11 個以閉鎖式復位，並以外固定架及經皮鋼釘固定。這樣的治療做成回顧性研究作比較。

結果：經複查平均 30 個月（範圍 24~50 個月），所有的骨折，均能癒合而沒有重大合併症。手腕關節在所有 12 個置放鋼板病人及 11 位中有 9 位外固定架病人，得到滿意的結果。

結論：任何一種手術方法都能提供很高的成功率。儘管每種方法都有本身的優缺點，以鋼板治療的結果似乎比較有利。手術醫師應該依照當時的情況，做比較有利的選擇。
(長庚醫誌 2006;29:388-94)

關鍵字：掌側巴頓氏骨折，支撐性鋼板，外固定架，克氏鋼釘。

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受文日期：民國94年11月15日；接受刊載：民國95年5月1日

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