Joint Diseases and Related Surgery

Jt Dis Relat Surg
2024;35(1):177-185

ORIGINAL ARTICLE

Volar buttress plate fixation: An effective and reliable option for Bennett's fractures

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ABSTRACT

Objectives: This study aimed to demonstrate the volar plate fixation technique for fixing Bennett's fractures due to its buttress effect.

Patients and methods: The retrospective study included 10 patients (8 males, 2 females; mean age: 35.9±11.56 years; range, 17 to 51 years) who were treated using the volar plate fixation technique between January 2018 and August 2022. The postoperative functional scores of the patients were evaluated using the Q-DASH (Quick Disabilities of the Arm, Shoulder, and Hand) score, and their pain status was evaluated with the Visual Analog Scale (VAS). We also assessed fracture union and development of complications. We assessed opposition according to Kapandji grade and abduction of the thumb.

Results: The mean follow-up time was 16.6±2.91 (range, 12 to 21) months. The technique was performed on the right extremity in eight patients and on the left extremity in two patients. All patients were right-hand dominant. The VAS score was 1 in two cases and 0 in the other cases. The mean Q-DASH score was 1.36±2.44. The mean pinch strength was 6.4±0.89 kg, and the mean grasp strength was 18.8±3.52 kg on the injured side. The mean Kapandji grade of opposition was 9.3±0.82, while the mean abduction degree was 37.4±2.01.

Conclusion: Based on the early results of this technique, we conclude that volar plate fixation for Bennett's fractures is reliable and allows for early motion, providing anatomical and stable joint reduction, and it does not have implant complications such as hardware irritation. However, fixation of small fragments may be particularly challenging.

Keywords: Bennett's fracture, buttress plate, fixation, fracture, thumb metacarpal base.

The thumb's wide range of motion depends on the anatomical structure of the carpometacarpal (CMC) joint, which allows it to perform circumduction and opposition.[1] The thumb relies on having a stable and pain-free CMC joint, particularly when performing pinch and grip actions. If there is any disruption to the anatomy of this joint, it can cause significant impairment to hand functions. Fractures occurring at the base of the first metacarpal may lead to stiffness, instability, and arthrosis in the CMC joint, which may adversely affect the thumb's function if not treated appropriately.[2-4]

Surgical treatments for fractures of the base of the first metacarpal, including closed reduction, pinning, and open reduction internal fixation, have been described.[5-7] There is currently no consensus on the treatment of these fractures. The primary goal of treating Bennett and Rolando fractures, which are intra-articular fractures, is to achieve precise reduction and restore the articular surfaces, to prevent CMC joint arthritis of the thumb.[8,9] Fluoroscopy is a common imaging technique used to evaluate joint reduction during closed reduction percutaneous pinning surgery. However, it has been found to be insufficient in accurately assessing the joint step and gap, which are critical for optimal reduction and preventing postoperative complications.[10] Both

Received: September 14, 2023
Accepted: November 09, 2023
Published online: November 30, 2023

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Doi: 10.52312/jdrs.2023.1427

Citation: Özdemir A, Şahin E, Durgut F, Acar MA. Volar buttress plate fixation: An effective and reliable option for Bennett's fractures. Jt Dis Relat Surg 2024;35(1):177-185. doi: 10.52312/jdrs.2023.1427.

TABLE I
Demographic data and clinical assessment

Case	Age/Sex (year)	Side	Injury type	Follow-up (month)	VAS	Q-DASH	Pinch (kg) Injured/non-injured side	Grasp (kg) Injured/non-injured side	Opposition according to Kapandji	Abduction degree of injured/non-injured side	Patient satisfaction score
1	32/M	R	Fall	18	0	0	7.5/7.5	24/22	10	39/40	100
2	44/M	L	OA	16	0	0	7.1/7.2	18/18	10	40/40	100
3	51/M	L	Fall	16	1	0	6.3/6.5	18/18	9	34/35	95
4	18/M	R	Fight	13	0	6.81	6.2/6.1	15/16	8	35/38	100
5	44/F	R	Fall	12	1	2.27	4.8/4.6	14/13	8	37/40	95
6	17/M	R	Fall	14	0	0	6.5/6.4	15/16	10	36/38	100
7	36/M	R	OA	18	0	0	6.5/6.3	22/22	9	40/38	95
8	44/F	R	Fall	20	0	4.54	5/5.1	18/17	9	38/38	100
9	30/M	L	Fall	16	0	0	7.1/7.3	22/22	10	38/39	95
10	43/M	R	OA	21	0	0	7/6.9	22/23	10	37/40	100

OA: Occupational accident; VAS: Visual Analog Scale; Q-DASH: Quick Disabilities of Arm, Shoulder and Hand Questionnaire.

dorsal and volar approaches are commonly used for the open reduction of these fractures.[11,12] In our technique for Bennett's fractures, we may evaluate the reduction of the volar aspect and support it with a buttress plate. The aim of this study was to present the volar buttress plate fixation technique for treating Bennett's fractures.

PATIENTS AND METHODS

The retrospective study included 10 patients (8 males, 2 females; mean age: 35.9±11.56 years; range, 17 to 51 years) who underwent treatment between January 2018 and August 2022. All surgeries were performed by a hand surgeon, and the minimum follow-up time was 12 months (Table I).

The current technique was indicated for displaced Bennett's fractures (Figure 1). It was contraindicated for epiphyseal fractures in young patients. During the procedure, the patient was placed in supine position. Prophylactic antibiotics were administered, and the tourniquet was inflated to a pressure 50 to 75 mmHg above the patient's systolic blood pressure. With the forearm in a neutral position, the abductor pollicis longus tendon was marked as a reference. A longitudinal incision was made along the radial side of the first metacarpal, and it was curved towards the wrist. Once the skin was incised, the dorsal branch of the radial nerve was identified and protected. The thenar muscles were elevated from the first metacarpal and trapezium to gain access to the fracture site. The fracture and joint capsule were exposed, and the joint capsule was incised longitudinally. During fixation, it was crucial to preserve the ligamentous connections of the bone fragments. Surgical exposure could be extended proximally and toward the origin of the thenar muscles to enhance visibility and facilitate fracture fixation. The reduction could be performed while visualizing the joint to ensure there were no steps or gaps on the joint surface. Once the reduction was achieved, the fracture could be temporarily fixed with a K-wire (Figure 2). A T-shaped 2.0 mini-plate (Zimed Medical Ltd., Gaziantep, Türkiye) was shaped according to the base of the first metacarpal and placed on the volar side as a buttress plate. The plate was then fixed with three or four screws, depending on the condition of the fracture (Figure 3). All steps were monitored by fluoroscopy. A short video showcasing the surgical technique and presenting functional clinical results is presented in this study (Video 1). Once the positions of the screws were verified, the joint capsule was closed with absorbable sutures. The thenar muscles were then sutured to

the radial edge of the first metacarpal. The skin was closed, and a short arm cast with thumb support was applied.

For rehabilitation, a thumb spica cast was applied for seven to 10 days after surgery. Then, the cast was removed, and patients were encouraged to start movements and perform exercises to improve their CMC joint range of motion. For the first four weeks, night splints were applied. Sutures were removed 10 to 14 days after the surgery. After the cast was removed, patients were advised to avoid strenuous activities with their hands for the first month after the operation. After the first month, light daily activity was allowed, then progress as tolerated. From the second month onwards, they were gradually permitted to resume their daily activities prior to the fracture.

The pain was evaluated on a scale of 0 to 10 using the Visual Analog Scale (VAS). Pinch and grip strengths were measured using a hand dynamometer

FIGURE 1. The preoperative radiological images of a Bennet's fracture are depicted in **(a, b)**, with the corresponding computed tomography image presented in **(c)**. Image **(d)** captures the patient in a splint during the early postoperative period, while **(e, f)** showcase the union at the last follow-up check.

and pinch gauge (Fabrication Enterprises Inc., New York, NY, USA) and compared with the contralateral extremity. The Quick-Disabilities of the Arm, Shoulder, and Hand (Q-DASH) questionnaire was administered to evaluate the outcome. Patients were also asked to rate their overall satisfaction on a scale of 0 to 100, where 0 indicated complete dissatisfaction and 100 indicated complete satisfaction. Union of the fracture was evaluated with radiographs taken in the first and second months (Figure 4). The absence of pain on palpation and the radiographic union was interpreted as union. All evaluations were made by the surgeon performing the surgery.

To assess thumb opposition, the Kapandji[13] test was used. During the test, the patient was asked to touch the middle phalanx (Grade 1), distal phalanx (Grade 2), and the fingertip (Grade 3) of the index finger. Afterward, the patient was asked to touch the thumb with the third finger (Grade 4), fourth finger (Grade 5), and fifth finger (Grade 6). Finally, the patient was asked to touch the thumb to specific points on the fifth finger, including the distal interphalangeal joint fold (Grade 7), proximal interphalangeal joint fold (Grade 8), proximal finger fold (Grade 9), and distal palmar fold (Grade 10). To measure thumb abduction and adduction, the

FIGURE 2. (a) illustrates reduction achieved through a volar approach, followed by the placement of a temporary K wire for reduction protection. **(b)** Subsequently, image **(c)** depicts the strategic placement of the plate after securing the volar K-wire, while **(d)** showcases the plate anatomically contoured to the metacarpal structure.

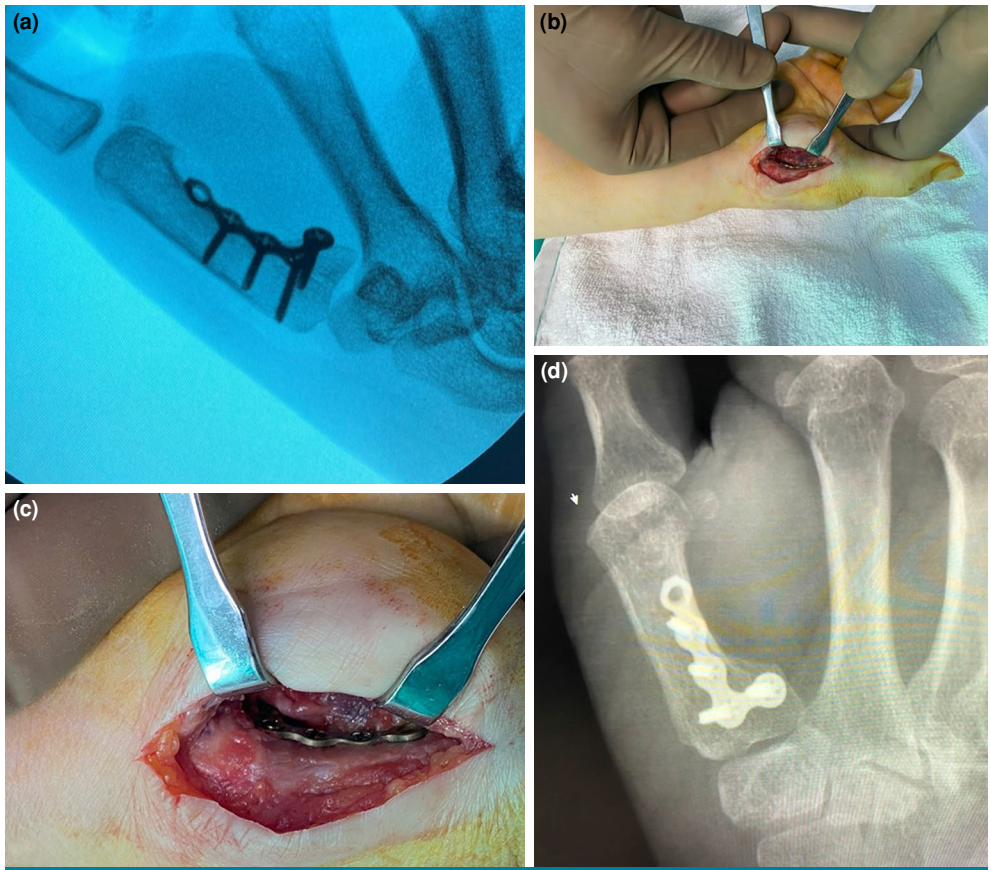

FIGURE 3. (a) A fluoroscopic image illustrating the placement of the plate on the volar aspect of the metacarpal in another. Distant **(b)** and close-up **(c)** images of the surgical approach during plate placement are displayed. The final image **(d)** captures the bone union observed during the last follow-up.

patient's forearm was positioned in pronation, and the wrist was maintained in a neutral position. Adduction movement was assessed by asking the patient to adduct their thumb. Abduction was measured with the thumb fully abducted, using a goniometer centered at the intersection of the first and second metacarpals and with the arm parallel to the metacarpals.

Statistical analysis

Statistical analyses were performed using SPSS version 14.0 software (SPSS Inc., Chicago, IL, USA). Since there was no comparison group in the study, descriptive statistics are presented.

RESULTS

The mean follow-up time was 16.6±2.91 (range, 12 to 21) months. Three patients sustained injuries to their left hand, while seven patients had injuries to their right hand. All patients were right-handed. Six patients sustained injuries due to falls, three due to occupational injury, and one due to a fight.

Demographic data and clinical results of all patients are presented in Table I. The mean postoperative VAS score was 0.2±0.42 (range, 0 to 1), and the mean postoperative Q-DASH score was 1.36±2.44 (range, 0 to 6.81). The mean pinch power was 6.4±0.89 kg (range, 4.8 to 7.5 kg) on the injured side and 6.4±0.93 kg (range, 4.6 to 7.5 kg) on the noninjured side. The mean grip power was 18.8±3.52 kg (range, 14 to 24 kg) on the injured side and 18.7±3.36 kg (range, 13 to "23 kg) on the noninjured side. The mean satisfaction score for the 10 cases was 98%, with a range of 95 to 100. This suggests a high level of patient satisfaction with the surgical outcome.

VIDEO 1. The video presents radiological images capturing a Bennett's fracture, the surgical reduction procedure, and the assessment of the fracture after plate placement. The final segment of the video illustrates the functional outcomes of the patient.

The mean opposition movement grade according to Kapandji was 9.3±0.82 (range, 8 to 10). The abduction angle on the injured side was 37.4±2.01° (range, 35 to 40°), while on the noninjured side, it was 38.6° (range, 35 to 40°).

All patients were able to resume their work or daily activities within 10 weeks after the injury, and there were no complications during the follow-up period (Figure 5). No hardware-related complications were observed in any of the cases, and no hardware removal was necessary. However, potential complications of this technique include injury of the superficial branch of the radial nerve, wound infection, and nonunion. All fractures healed without any complications.

DISCUSSION

The current technique offers several advantages, including anatomical reduction of the joint, stable fixation allowing for early movement, and placement of the plate under a large muscle mass; this placement may decrease the need for removal after the union, as it avoids skin irritation.[14]

However, the technique may have some disadvantages in Bennett's fractures with small bone fragments, as the plate's buttress on the fracture pieces may be insufficient. During the application of the technique, the most challenging part is placing the plate on the volar surface and, in particular,

FIGURE 4. Radiography of the fracture taken after it has healed.

FIGURE 5. Visual of the patient's range of motion after the fracture has healed.

the placement of the screws. Inserting screws into the proximal-deep part of T-shaped plates poses technical challenges. To facilitate this step, temporary fixation of the fractured part of the metacarpal with a K-wire may be done, and the metacarpal bone may be supinated for easier screw placement. Therefore, appropriate patient selection and preoperative planning are critical to the success of the technique.

The importance of restoring the articular surface in fractures of the base of the first metacarpal cannot be underestimated, as it is critical for maintaining the stability of the CMC joint and allowing pain-free joint motion. Anatomical reduction of the articular surface is a crucial factor that affects clinical outcomes in the postoperative period. Capo et al.[10] showed that the use of fluoroscopy during closed reduction percutaneous pinning for evaluating fracture reduction does not provide accurate results. This increases the risk of instability and arthrosis in the postoperative period in fractures involving the base of the first metacarpal joint treated with closed reduction and pinning.

Uludag et al.[3] studied eight patients fixed with screws and eight with plate screws, reporting union in all with no CMC joint arthrosis, with a mean follow-up of 15.6 (range, 12 to 36) months. While their mean VAS score 1.06 (range, 0 to 3) was slightly higher than ours (0.2±0.42), both studies noted satisfactory DASH and Q-DASH scores. The grip and pinch power in our study matched the uninjured side, while Uludag et al.[3] observed a slight decrease on the injured side. Both studies highlight the significance of anatomical reduction and stable fixation for achieving satisfactory results, including a satisfactory range of motion in both cases.

In the study conducted by Pomares et al.,[15] they presented outcomes of screw fixation in two case groups involving arthroscopic and open reduction. Complications, including malunion, pain, reduced return to previous activity, and paresthesia, were reported in six out of 10 patients treated with open reduction and screws. Additionally, four patients in this group experienced screw migration into the joint. Nonunion was not reported. A singular case of regional pain syndrome was reported in the arthroscopically reduced group fixed with percutaneous fixation. Both groups exhibited significant improvement in Q-DASH scores during follow-up, similar to our results. In contrast to our study, Pomares et al.[15] opted for a prolonged application of a spica cast. This choice may stem from the perceived advantage of the volar buttress plate in facilitating early movement compared to screws. Additionally, it is worth noting that the arthroscopic method employed in Pomares et al.'s[15] study necessitates a considerable amount of additional equipment and surgical expertise in arthroscopy.

Closed or open reduction and fixation using K-wires is a commonly used method. However, one of the disadvantages of this method is that K-wires lack compressive capability at the fracture site, which may lead to poor fracture reduction and stability.[16,17] The authors obtained clinical results similar to those of the healthy side in terms of grip strength, pinch strength, and joint range of motion. In our study, although the sample size was smaller, we obtained clinical outcomes similar to Zhang et al.[7]'s study, which can be attributed to the anatomical reduction and rigid fixation of the joint in both methods. Although our follow-up period was short, no hardware-related complaints or complications were reported by the patients, and unlike Zhang et al.'s[7] study, hardware removal was not required.

The use of open reduction and plate fixation is preferred due to its ability to provide stable fixation

and early mobilization.[3] Bennett's fractures may be treated with either a dorsal or volar approach. However, long-term soft tissue problems, particularly in dorsal plate applications, may arise. Mumtaz et al.[18] found that four out of nine patients who were treated with a dorsal plate experienced local tenderness and pain, which resulted in the early removal of the plate and screws. The reduction of the volar part in Bennett's fractures may be difficult to identify and evaluate with the dorsal approach.[8,19] The use of a volar approach provides much better exposure for direct reduction and stabilization of the fracture. The use of a volar approach and volar plate fixation may facilitate early rehabilitation and improve the range of motion and functional capacity.

This study has several limitations, including its retrospective design and small sample size. Furthermore, the absence of a control group makes it challenging to draw definitive conclusions. Another limitation is the short follow-up duration, which may not have been sufficient to detect the possible development of osteoarthritis. Finally, the preference for using this technique in Bennett's fractures with larger bone fragments may also have introduced some degree of selection bias.

In conclusion, the initial outcomes of our study demonstrate that the volar plate fixation technique is a dependable and safe method for achieving stable fixation with fewer complications in the treatment of fractures involving the base of the first metacarpal. Furthermore, this technique allows for early mobilization, which can be advantageous for postoperative rehabilitation. Nevertheless, to evaluate the effectiveness of this method accurately, further research involving larger sample sizes and longer follow-up periods with control groups is required.

Ethics Committee Approval: The study protocol was approved by the Selcuk University Faculty of Medicine Local Ethics Committee (date: 18.07.2023, no: 2023/14). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from the patients and/or parent of the patients.

Data Sharing Statement: The datasets generated or analyzed during the current study are not publicly available due to (within the scope of the personal data protection law applied in our country) but are available from the corresponding author on reasonable request.

Author Contributions: Idea/concept: A.Ö., F.D.; Design: A.Ö., E.Ş.; Control/supervision: M.A.A.; Data collection and/or processing: A.Ö., M.A.A.; Analysis and/or interpretation: E.Ş., M.A.A.; Literature review, writing the article, references and fundings: A.Ö., F.D.; Critical review: E.Ş., M.A.A.; Materials: A.Ö.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

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