


A novel approach to the proximal interphalangeal joint: The volar oblique incision – a retrospective cohort study

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Abstract

Background: The surgical approach to the volar structures in the digits must be designed to provide adequate exposure of tendons, vessels and nerves but also in a way that prevents flexion contracture of the digit as the scar contracts. This is traditionally done using a zigzag ‘Bruner’ incision, first described by Dr Julian M Bruner in 1967. In this paper, we describe an alternative approach, the Volar Oblique incision, and present a single institutional cohort of patients who have undergone procedures beginning with this approach.

Methods: A retrospective cohort study was performed on eight cases that involved a Bruner incision and eight similar cases that involved a volar oblique incision. Charts were reviewed for demographic data. Patients were asked to return to clinic postoperatively for scar assessment using the Patient and Observer Scar Assessment Scale (POSAS), where lower scores correspond to more favourable scar characteristics. The average follow-up period was 22 months. While in clinic, standard joint measurements were taken to assess for any proximal interphalangeal joint contracture. Demographics and questionnaire data were analysed using the Mann–Whitney U test for non-parametric data and quantitative joint measurements were analysed using Student’s *t*-test.

Results: There was no difference in flexion contracture between the two groups. The POSAS patient score for scar irregularity was lower in the volar oblique group compared to the Bruner group, but there was no difference in any of the other subcategories, the total patient score, nor the overall patient opinion. The total POSAS observer score was lower in the volar oblique group compared to the Bruner group, with lower scores in the scar thickness, observed relief and observed pliability subcategories as well as the overall observer opinion.

Conclusion: The volar oblique incision appears to be satisfactory alternative to the classic Bruner incision in hand surgery that requires volar exposure of the digits. Future studies are needed to assess the validity of these findings on a larger scale.

Keywords

Volar oblique, Bruner, flexor-tendon incision, hand surgery

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Lay Summary

There are various types of incisions that surgeons use when they operate on fingers. When choosing an incision, it is important that the incision provides good exposure to the deeper structures but does not form a tight scar that limits movement of the finger (contracture).

A commonly used incision for the palmar side of the finger is the zig-zag or 'Bruner' incision. Some people, however, find this zig-zag scar unappealing. We started using a single diagonal incision, which we have called the volar oblique, instead of the zig-zag Bruner for access to the middle joint of the finger. We wanted to describe the volar oblique technique and then compare the quality of these two scars and also assess if one limits movement of the finger more than the other.

Our research found no differences in finger contracture between groups. We did, however, find that patients reported scar irregularity more favourably in the volar oblique group and that surgeons rated scar thickness, relief (roughness) and pliability of the volar oblique scar higher than that of the zig-zag Bruner scar.

This research presents a novel surgical technique and compares its results with respect to scar quality and finger contracture to the more traditional zig-zag Bruner approach.

Introduction

The surgical approach to the volar structures in the digits must be designed to provide adequate exposure of tendons, vessels and nerves but also in a way that prevents flexion contracture of the digit as the scar contracts. This is traditionally done using a mid-lateral approach or a zig-zag volar incision, first described by Dr Julian M Bruner in 1967.¹

Dissatisfied with the mid-lateral approach for tendon graft surgery that was standard in his time, Bruner described a zig-zag incision which crisscrossed the course of the flexor tendon in the digit with hinges at the level of the skin creases resulting in angles greater than 90° (Figure 1). In a lecture delivered at the Royal College of Surgeons of England in 1972, Bruner stated that this design was prompted by an accidental zig-zag glass cut on the finger of a young student sustained while bartending.² The ready-made incision reportedly provided excellent exposure, a successful zone 2 primary tendon repair and a very favorable scar. A 'modified mid-lateral incision' for volar approach to the digit has also been described, incorporating both the Bunnell mid-lateral incision and the Bruner zig-zag; it is thought to provide rapid exposure without risking flexion contractures and maintaining an intact volar skin flap.³

Criticisms of the traditional mid-lateral incision include its difficulty in approaching the volar digit at the level of the proximal interphalangeal (PIP) joint due to entanglement of Cleland's ligament, the transverse retinacular ligament and the joint capsule.^{3,4} Full exposure of the volar digital sheath and contralateral neurovascular bundle is also thought to be a problem with this approach. Other described approaches include a W-shaped incision which crosses the volar longitudinal midline over

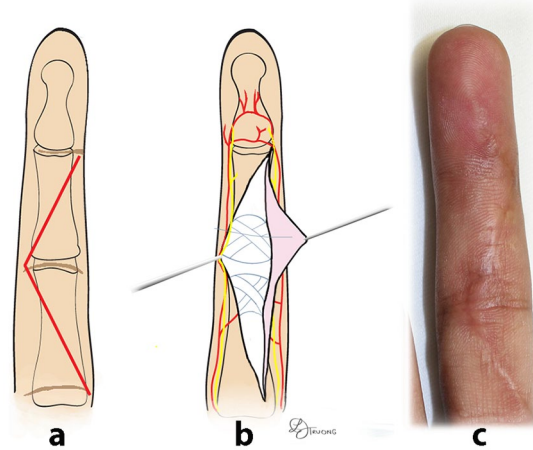


Figure 1. The Bruner zig-zag incision: (a) planning; (b) exposure; and (c) mature scar.

the proximal and distal phalanx, and is thought to have the same disadvantages as the Bruner incision.^{3,5} The modified mid-lateral incision is thought to avoid flexion contracture, be fast to close and have adequate exposure to the contralateral neurovascular bundle, but is not commonly described.³

In his original article, Bruner did allude to possible disadvantages of his zig-zag approach. These included sensitive or disfiguring scars, sensory disturbances in the volar skin, flexion contractions and adhesions within the flexor tendons. Other anecdotal criticisms of this technique include more difficult skin approximation secondary to wider exposure and swollen tissues, and suboptimal incision placement over gliding structures that may reduce comfort in early exercises.⁶ To date, there has been little assessment of the outcome of the Bruner incision or complications related to it.^{7,8}

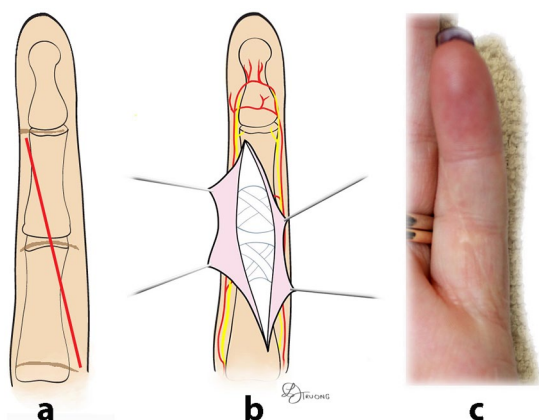


Figure 2. The volar oblique incision: (a) planning; (b) exposure; and (c) mature scar.

We introduce here the volar oblique incision as an alternative to the Bruner approach to the PIP joint and present a case series comparing the two different approaches.

Technique

The incision begins proximal to the distal interphalangeal joint, medial to the neurovascular bundle, and extends obliquely along the volar surface of the digit, across the PIP joint and ceases just distal to the metacarpophalangeal joint, without crossing the neurovascular bundle laterally (Figure 2). The edges of the incision can then be reflected using fine skin hooks for adequate exposure. Proposed advantages of this incision include lesser incidence of flexion contracture and a better cosmetic result. While we have used this volar oblique incision for digital access in many different pathologies, it has predominantly been used by our group for exposure of the PIP joint for joint release and volar PIP joint arthroplasty.

Materials and methods

A retrospective cohort study was performed. The study was reviewed and approved by the Research Ethics Board at the University of Western Ontario (REB#108723). Informed consent was obtained from all patients for being included in the study. Patients were voluntarily recruited from a university-based hand and upper limb clinic over a one-month period. Inclusion criteria were age greater than 18 years and patient having undergone surgery with either a volar oblique or Bruner incision on any digit. Exclusion criteria were scar age less than six months. Intraoperative notes and pre- and postoperative clinic notes were reviewed,

and patients were asked to return to clinic for photographic documentation and formal scar evaluation. Primary outcome measures were patient perception of scar characteristics, patient satisfaction, observer assessment of scar characteristics, observer satisfaction and flexion contracture of the PIP joint.

Patient perception of scar characteristics was evaluated with the patient component of the Patient and Observer Scar Assessment Scale (POSAS), a validated scar assessment scale.^{9,10} Each of the patient and observer scales consist of six subcategories, that are summed to generate a total score. There is also an independent overall opinion rating for both the patient and observer that represents the overall severity of the visual and tactile characteristics of the scar. The overall opinion rating is not included in the total score and is analysed separately from the other subcategories. A plastic surgery resident not involved in the treatment served as a skilled observer who filled out the observer component of the POSAS scale. Lower ratings on these assessment scales correspond to a scar result that is closer in appearance to normal skin. A standard goniometer was used to measure PIP flexion contracture, if present. Any flexion contractures in which the scar pliability was qualified as ‘supple’ were excluded from the analysis. After data collection, postoperative quantitative measurements and questionnaire scores were compared between the volar oblique and Bruner groups. Demographic data and questionnaire scores were treated as independent, non-parametric data and were analysed using the Mann–Whitney U test and, unless otherwise specified, results are reported as median values. The normality of PIP flexion contracture values was confirmed using the D’Agostino and Pearson test and therefore statistical analyses of this quantitative data were performed using the independent samples *t*-test and, unless otherwise specified, results are reported as mean values. Statistical significance was set at $\alpha = 0.05$, and therefore was only achieved with a *P* value < 0.05 or at a confidence level $> 95\%$. All comparisons made are of the volar oblique group to the Bruner group, unless otherwise specified. Statistical analyses were performed using GraphPad Prism 8 for macOS (GraphPad Software, La Jolla, CA, USA, www.graphpad.com).

Results

Sixteen patients with a variety of surgical indications were operated on with either the volar oblique or Bruner incision (Table 1). When

Table 1. Patient characteristics.

	Median value		P value
	Volar oblique (n = 8)	Bruner (n = 8)	
Patient age (years)	54.0	48.50	0.263
Scar age (months)	24	13	0.137
Number of surgeries through same incision	1	3	0.019
Sex (number of patients)			0.282
Female	4	1	
Male	4	7	
Surgical indication (number of cases)			
Post-traumatic flexor tenolysis/capsulotomy/tendon grafting	6	7	
Excision of cyst	1	0	
Congenital deformity	0	1	
Synovitis	1	0	

comparing the volar oblique group to the Bruner group, the median patient age in years (54 vs. 48.5, $P = 0.263$), gender (4F:4M vs. 1F:7M, $P = 0.282$) and the median scar age in months (24 vs. 13, $P = 0.137$) were similar across the two groups. The median number of surgeries performed through the same incision in the Bruner group was more than that of the volar oblique group (3 vs. 1, $P = 0.019$). The main indication for surgery in both groups was post-traumatic flexor tenolysis.

There was no difference in average PIP joint flexion contracture in the volar oblique group compared to the Bruner group (8.75° vs. 13.13° , $\Delta = 4.38$, $P = 0.672$, 95% confidence interval [CI] = -17.33 to 26.08).

Patient-reported scar irregularity, one of the POSAS patient subcategories, was lower in the volar oblique group compared to the Bruner group (1.5 vs. 5, $\Delta = 3.5$, $P = 0.042$, 95% CI = $0-5$). There was, however, no difference in total patient score (8 vs. 17.5, $\Delta = 9.5$, $P = 0.085$, 95% CI = -9 to 14) or difference in any other subcategory for POSAS patient scores or overall patient opinion rating in the volar oblique group compared to the Bruner group (Table 2).

Skilled third-party observer evaluation demonstrated a median total POSAS observer score that was lower in the volar oblique group compared to the Bruner group (18 vs. 26.5, $\Delta = 8.5$, $P = 0.026$, 95% CI = $2-16$). The observer-rated median scar thickness (3 vs. 5.5, $\Delta = 2.5$, $P = 0.030$, 95% CI = $0-4$), relief (3 vs. 5.5, $\Delta = 2.5$, $P = 0.007$,

95% CI = $1-3$) and pliability (3 vs. 5, $\Delta = 2$, $P = 0.008$, 95% CI = $1-4$) were the individual scar parameters that were rated lower in the volar oblique group compared to the Bruner group (Table 3). The overall observer opinion rating was also lower in the volar oblique group compared to the Bruner group (3 vs. 5.5, $\Delta = 2.5$, $P = 0.032$, 95% CI = $0-4$).

Discussion

The volar oblique incision came into use at our institution as an alternative to the traditional Bruner incision for PIP joint access. We felt that this new incision provided excellent visualisation of volar structures, a more aesthetically appealing scar than the traditional Bruner approach and no increased incidence of flexion contracture. Our investigations begin to support these claims by demonstrating no increased incidence of flexion contracture in patients having undergone surgery with the volar oblique incision compared to the classic Bruner incision. Patients subjectively rated the volar oblique scar more favourably than the Bruner in the scar irregularity subcategory and a skilled observer subjectively rated the volar oblique scar better than the Bruner, specifically in the scar thickness, relief and pliability subcategories, but also in the independent overall observer opinion rating. The strengths of this study include the description of a novel technique, but also the presentation of

Table 2. POSAS patient score results: median scores and differences.

	VO (n = 8)	Bruner (n = 8)	Difference ($\Delta = VO - Bruner$)	95% CI of difference	P value
Pain	1	1	0	-1 to 1	0.733
Itching	1	1	0	-1 to 1	1.000
Scar colour	2	3	1	-2 to 2	0.474
Scar stiffness	1.5	5.5	4	-1 to 5	0.083
Scar thickness	2	5	3	-1 to 5	0.126
Scar irregularity	1.5	5	3.5	0-5	0.042
TPS	8	17.5	9.5	-9 to 14	0.085
OPO	2	3	1	-1 to 3	0.230

Note the six subcategories are summed to generate the TPS. The OPO is reported afterwards and is treated independently from the other items. CI, confidence interval; OPO, overall patient opinion; POSAS, Patient and Observer Scar Assessment Scale; TPS, total patient score; VO, volar oblique.

Table 3. POSAS skilled observer score results: median scores and differences.

	VO (n = 8)	Bruner (n = 8)	Difference ($\Delta = VO - Bruner$)	95% CI of difference (Δ)	P value
Vascularity	3	3	0	0-3	0.265
Pigmentation	3	3.5	0.5	-1 to 2	0.499
Scar thickness	3	5.5	2.5	0-4	0.030
Observed relief	3	5.5	2.5	1-3	0.007
Observed pliability	3	5	2	1-4	0.008
Observed surface area	3	4	1	-1 to 3	0.095
TOS	18	26.5	8.5	2-16	0.026
OOO	3	5.5	2.5	0-4	0.032

Note the six subcategories are summed to generate the TOS. The OOO is reported afterwards and is treated independently from the other items. CI, confidence interval; OOO, overall observer opinion; POSAS, Patient and Observer Scar Assessment Scale; TOS, total observer score; VO, volar oblique.

both objective and subjective data, including patient-reported outcomes on the results of this novel technique, compared to the most commonly used alternative.

One hypothesis for the significantly improved patient perception of scar irregularity in the volar oblique group may be inherent in its design: a straight line is fundamentally 'regular' or 'consistent'. The zig-zag incision, involving two diverging lines centered on a transverse crease is inherently irregular as it contains a 'turn'. The tips or 'corners' of the Bruner skin flaps are also high-risk areas for necrosis and healing issues

secondary to poor soft tissue quality or handling. We were also of course unable to blind the skilled observer to the incision type, and perhaps there was an unconscious bias in evaluating these scars.

Currently there are no studies examining contracture rates associated with the Bruner approach specifically. Other studies have examined PIP joint contracture rates in homodigital island flaps,¹¹ but typical incisions associated with these flaps have been mid-lateral. One study, however, has described a 'moderate' deficit in extension at the PIP joint (20°) in two of 32 patients receiving homodigital neurovascular

island flaps with a Bruner style incision crossing the PIP joint.¹² There are no papers that describe such an approach as our described volar oblique incision, although a ‘digital palmar oblique incision’ has been described. This incision greatly differs from our described approach, however, as it involves transverse incisions at the joint creases.¹³

There are of course limitations to this study. First, the small sample size leads to wide confidence intervals which limits potential conclusions and could lead to a higher rate of type 2 error. Second, assessing flexion contracture of the PIP joint after flexor-tendon surgery is difficult because the joint could be contracted due to skeletal, ligamentous, tendinous or cutaneous factors. In this study, we attempted to isolate cutaneous scar contracture by excluding any joint contracture for which the scar pliability was rated as supple. This relies on the assumption that a contracted joint with a supple scar must be contracted as a result of a structure other than the skin. A more objective measure of skin elasticity could have been obtained using a skin elasticity meter, such as the *Cutometer SEM 575*, which has been shown to be a reliable measure of dermal elasticity independent of skin thickness.¹⁴ Third, the increased number of operations through the same incision in the group of patients with the Bruner incision may represent a confounding factor in the ratings on the scar assessment scales.

We believe the volar oblique incision for approach to the PIP joint is a suitable alternative to the classic Bruner incision. Further study with a larger cohort of patients as well as advanced tools to quantitatively measure specific scar parameters would allow us to better reinforce these findings.

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