e-ISSN:2602-2079

Volume 10
Issue 1
2026

JOURNAL
of
Surgery and Medicine

International Medical Journal

JOSAM

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Vol. 10 No. 1 (2026)

Published: 2026-01-31

Research Article

FDMA-based kite flap reconstruction for post-burn first web space contractures: A retrospective study
Treatment of first web space burn contractures
Cenk Melikoglu
1-6
PDF 36 37 Citations 0

The effect of dietary total antioxidant capacity of individuals with type 2 diabetes on metabolic and oxidative parameters: A cross-sectional study
Dietary antioxidant capacity in type 2 diabetes
Özlem Özpak Akkuş, Meltem Mermer, Ramazan Gen, Mehmet Burak Yavuz Çimen, Antonios Koutelidakis, İhsan Dönmez
7-14
PDF 70 59 Citations 0

Clinical outcomes of lateral digital flap–based local flap combinations in the reconstruction of post-burn metacarpophalangeal joint contractures
Management of MP joint post-burn contractures
Cenk Melikoglu
15-19
PDF 33 38 Citations 0

Red cell distribution width to platelet count ratio as a predictor of severity in acute biliary pancreatitis
A cross sectional study in a tertiary care center
Kalpana Acharya, Amit Prajapati, Ekata Karna, Shanta Bir Maharjan
20-23
PDF 12 17 Citations ?

Review

Nursing care plans for patients with ventricular assist devices: A holistic evaluation based on clinical observations and practice recommendations

Ventricular assist device nursing

Neslihan Bektaş

24-29

PDF

56 76 Citations 0

Case Report

Os trigonum syndrome with clinical and radiological findings

Os trigonum

Demet Doğan, Nurbanu Baş

30-32

PDF

83 44 Citations 0

Hybrid repair of early aortobifemoral graft occlusion in a patient with antiphospholipid syndrome: A case report

Hybrid repair of graft occlusion in APS

Laurens Vermylen, Geert Daenen, Patrick Stabel, Jo Avet, Karen Peeters

33-36

PDF

0 0 Citations ?

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J Surg Med. 2026;10(1):1-6.
https://doi.org/10.28982/josam.8495
JOSAM
Journal of Surgery and Medicine
e-ISSN: 2602-2079
Research article
https://jsurgmed.com/

FDMA-based kite flap reconstruction for post-burn first web space contractures: A retrospective study

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Ethics Committee Approval
Written informed consent was obtained from all patients for surgical treatment and the use of clinical photographs. Ethics committee approval was obtained before study initiation.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 January 8

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Abstract

Background/Aim: Post-burn first web space contractures significantly impair thumb abduction and overall hand function. This study aimed to evaluate the short- to mid-term clinical outcomes of a first dorsal metacarpal artery (FDMA)–based kite flap following complete release of post-burn first web space contractures.

Methods: This retrospective case series included five patients with post-burn first web space contracture. In all cases, complete release of the contracture was performed, followed by reconstruction of the resulting defect using an FDMA-based kite flap. In one patient, a concomitant fifth-finger flexion contracture was corrected with a cross-finger flap during the same session. The primary outcome measure was first web space opening, assessed preoperatively and postoperatively using a goniometer in a standardized clinical position.

Results: The mean preoperative first web space opening was 70.0 (3.5), which increased to 90.0 (0.0) postoperatively, corresponding to a mean improvement of 20.0 (3.5). Follow-up ranged from 5 to 7 months. In all patients, the achieved web space opening was preserved throughout follow-up, and no residual or recurrent contracture was observed.

Conclusion: Reconstruction of post-burn first web space contractures using an FDMA-based kite flap after adequate release provides reliable restoration and maintenance of web space opening in the short to mid-term. This technique represents a stable and functional reconstructive option in selected patients when a true soft tissue defect is present after contracture release.

Keywords: first web space; burn contracture; first dorsal metacarpal artery; kite flap; web space opening

How to cite: Melikoglu C. FDMA-based kite flap reconstruction for post-burn first web space contractures: A retrospective study. J Surg Med. 2026;10(1):1-6.

Introduction

The first web space, defined as the interval between the thumb and the index finger, constitutes a central functional unit of the hand. Adequate opening of this space permits palmar abduction of the thumb, which determines grip span and enables effective performance of power grip, key pinch, and precision pinch. Limitation of the first web space therefore causes a disproportionate decline in overall hand function relative to the apparent local deformity. Early hand surgery literature emphasized that thumb adduction contracture should not be regarded as an isolated cosmetic or regional problem, but as a condition with broad biomechanical and functional consequences [1].

Littler's work established that restriction of thumb abduction alters grasp geometry and reduces efficiency across nearly all grip patterns [1]. When the thumb cannot abduct sufficiently, its relationship to the index and remaining fingers is disrupted, resulting in compromised object acquisition, reduced grip stability, and impaired fine motor control. Herrick and Lister further demonstrated that preservation and reconstruction of the first web space are critical not only for primary hand function but also for the success of secondary procedures such as opponensplasty and tendon transfers, which rely on an adequately positioned and mobile thumb [2].

Clinically, patients with first web space contracture often report a subjective "loss of hand strength", which commonly reflects mechanical disadvantage rather than true muscular weakness. When thumb positioning is constrained by web space narrowing, force transmission during grasp becomes inefficient and functional performance deteriorates. Sandzen emphasized that the first web space should be considered a three-dimensional functional volume rather than a simple angular measurement [3]. Within this framework, durable reconstruction should address not only widening but also restoration of depth, contour, and tissue compliance.

Post-burn contractures of the first web space are particularly challenging. Burn scars are characterized by disorganized collagen deposition and prolonged remodeling, leading to progressive contractile forces that may persist long after epithelial healing. Due to thin skin coverage, limited subcutaneous tissue, and exposure to multidirectional tensile stresses, the first web space is especially vulnerable to secondary contracture formation after burns. Bhattacharya noted that burn-related first web space contractures frequently extend beyond superficial skin involvement to include deeper structures such as fascia, tendon sheaths, and intrinsic muscle compartments [4]. Consequently, these deformities may evolve from simple scar bands into complex, volume-deficient contractures.

The biological behavior of burn scars complicates surgical management because scar tissue tends to re-shortening, particularly in highly mobile regions. Del Piñal et al. [5] emphasized that failure to prevent or correct early posttraumatic web space narrowing may lead to permanent functional impairment, underscoring the importance of timely and definitive intervention. In long-standing cases, adaptive changes may also occur in osseous alignment and capsuloligamentous structures, further limiting the effectiveness of delayed release.

Recognizing the heterogeneity of post-burn first web space contractures, Grishkevich [6] proposed a classification based on contracture depth, extent, and tissue involvement, providing a structured framework for surgical decision-making. This approach reinforces that no single reconstructive method is universally applicable and that treatment should be tailored to the specific characteristics of each deformity. Superficial contractures with preserved tissue volume may respond to local rearrangement, whereas deeper, volume-deficient contractures require more robust reconstructive strategies.

The objective of surgery in first web space contractures is twofold: complete release of all restricting structures and durable preservation of the achieved opening. Simple division of scar bands is insufficient when release results in a true soft tissue defect. Hastings and Davidson emphasized that inadequate primary correction may compromise subsequent reconstructive efforts and limit functional recovery [7]. Therefore, surgical success depends not only on the extent of release but also on the quality and stability of the reconstruction used to fill the resultant defect.

Multiple reconstructive options have been described. Z-plasty and its modifications can be effective for linear, superficial contractures by providing lengthening through tissue rearrangement [8]. However, their utility is limited in burn sequelae when tissue quality is poor and volume deficiency is prominent. The square flap technique described by Hyakusoku and Fumiiri [9] introduced a geometric approach aimed at restoring three-dimensional volume within contracted webs. Subsequent applications of the square flap in axillary and digital web contractures support its conceptual value in selected scenarios [11]. Afzal et al. [10] also reported favorable outcomes with the square flap for post-burn first web space contractures, highlighting its role as an option in appropriate cases.

Despite these advances, secondary contraction remains a major concern, particularly when reconstruction relies on skin grafts alone. Comparative studies indicate that perforator-based interposition flaps provide superior resistance to re-contracture compared with full-thickness skin grafts after burn scar release [12]. Reviews similarly support the role of vascularized flap tissue in maintaining functional gains after contracture release [13]. These data emphasize the importance of interposition tissue that provides coverage, structural support, and resistance to recurrent shortening.

Post-burn hand deformities often involve multiple anatomical units, and addressing a single contracture in isolation may limit overall functional recovery. Sunil et al. [14] reported that combined involvement of multiple fingers or web spaces is common in post-burn hands, supporting a comprehensive reconstructive approach. Algorithmic treatment strategies for first commissure burns similarly highlight the need to integrate release, reconstruction, and rehabilitation into a coherent plan [15].

Within this landscape, the first dorsal metacarpal artery (FDMA)–based kite flap is a reliable local option for perithumb and first web space reconstruction. Originally described by Foucher and Braun [16], this island flap uses the consistent vascular anatomy of the dorsal index finger to provide thin, pliable, well-vascularized tissue suitable for web space reconstruction. The anatomical reliability of the FDMA flap is supported by vascular studies describing the arterial supply of the thumb, first web space, and index finger [17].

Clinical series have reported favorable outcomes with the FDMA flap in traumatic and post-burn thumb deformities. Eski et al. [18] emphasized its versatility in burn-related thumb deformities, noting stable coverage and functional improvement. Retrospective analyses further support its practicality in clinical use [19]. More recently, the FDMA flap has been described as a dependable technique appropriate for routine thumb reconstruction [20].

Accordingly, the present study evaluates management of post-burn first web space contractures using an FDMA-based kite flap after complete contracture release. By objectively measuring first web space opening preoperatively and postoperatively, this case series aims to clarify the role of the FDMA flap as a stable reconstructive option in selected patients with volume-deficient post-burn first web space contractures.

Materials and methods

Study design and patient population

This study was designed as a retrospective descriptive case series of patients who underwent surgical treatment for post-burn first web space contracture between May 2010 and April 2011. Five patients were included. All patients presented with progressive narrowing of the first web space secondary to childhood burn injuries, resulting in limitation of thumb palmar abduction and impaired hand function. A case series design was selected because post-burn first web space contractures are relatively uncommon and clinically heterogeneous, and focused reporting of surgical rationale and early outcomes remains informative [14, 15].

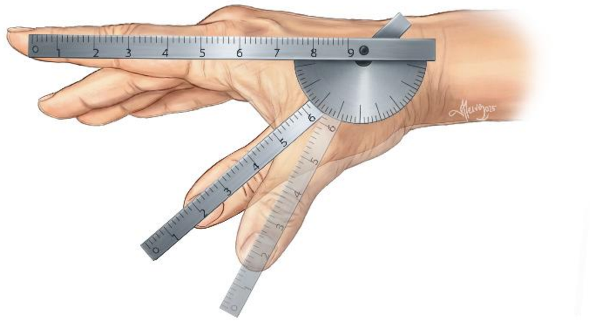
Burn etiology and contracture characteristics

In all patients, contracture etiology was a childhood domestic burn injury, predominantly stove contact burns and scald injuries from hot liquids. Initial burn management had been conservative in all cases. The first web space was involved in all patients. One patient also had an associated fifth-finger flexion contracture, consistent with reports that post-burn deformities frequently involve multiple anatomical units [14]. Intraoperative assessment confirmed that contractures extended beyond superficial scar bands into deeper planes, consistent with deeper contracture patterns described in post-burn classification systems [6].

Clinical evaluation and measurement method

The primary outcome measure was first web space opening (first web span), defined as the maximum achievable opening between the thumb and index finger during palmar abduction. Measurements were obtained preoperatively and postoperatively using a standardized protocol. Patients were evaluated seated, with the forearm in neutral rotation and the hand supported on a flat surface. The thumb was brought into maximum tolerated palmar abduction, and the angle corresponding to first web space opening was measured with a goniometer. This approach aligns with commonly used clinical assessment methods for thumb web reconstruction [3]. To minimize interobserver variability, all measurements were performed by the same examiner throughout the study period under consistent conditions (Figure 1).

Figure 1: Measurement method with goniometer

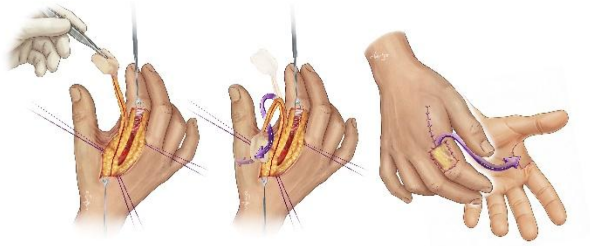


Surgical technique

Contracture release

In all cases, surgery began with complete release of the first web space contracture. Release was not limited to superficial scar incision but was performed to eliminate all fibrotic structures restricting thumb palmar abduction. Dissection continued until full passive opening of the web space was achieved. After release, a true soft tissue defect was present in all patients, indicating tissue deficiency rather than isolated linear shortening (Figure 2). Because lack of defect reconstruction is associated with a high risk of recurrent contracture, interposition reconstruction was performed in all cases [5].

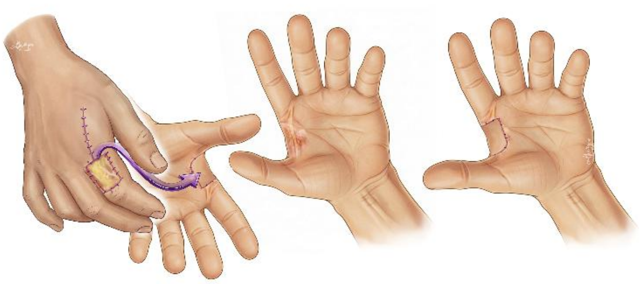
Figure 2: Surgical technique and flap elevation.



FDMA-based kite flap reconstruction

Reconstruction of the post-release defect was performed with an FDMA-based kite flap. This island flap was elevated from the dorsal aspect of the index finger and supplied by the first dorsal metacarpal artery, using the technique described by Foucher and Braun as the technical basis [16]. The flap was transposed into the first web space as interposition tissue to provide coverage and restore web space volume (Figure 3). The reconstructive aim was stable restoration of three-dimensional volume with resistance to secondary contraction, supported by the dependable vascular anatomy of the FDMA pedicle [17,18].

Figure 3: Final result of contracture release.



Additional procedures

In one patient, a concomitant fifth-finger flexion contracture was corrected during the same session using a cross-finger flap. Addressing multiple deformities in a single operation aimed to restore both radial and ulnar functional columns of the hand, consistent with comprehensive strategies described for complex post-burn deformities [14].

Postoperative care and rehabilitation

Flap viability was monitored clinically, and no early complications such as vascular compromise or wound-related problems were observed. Immobilization was maintained during the initial healing period. Rehabilitation was initiated during the first postoperative month after wound healing, focusing on gradual restoration of thumb motion and maintenance of the achieved web space opening, consistent with algorithmic approaches to first web space management [15].

Ethical considerations

All procedures were performed according to institutional standards and the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients for surgical treatment and the use of clinical photographs. Ethics committee approval was obtained before study initiation.

Results

Five patients with post-burn first web space contracture were included. The cohort had a narrow age range (21–22 years). All contractures resulted from childhood domestic burn injuries, predominantly stove contact burns and scald injuries. The first web space was affected in all patients, and one patient additionally presented with a fifth-finger flexion contracture. Patient characteristics are summarized in Table 1.

Preoperative clinical examination demonstrated marked limitation of thumb palmar abduction in all patients, corresponding to narrowing of the first web space. Representative preoperative appearances of isolated and combined deformities are shown in Figure 4a and Figure 5a.

Figure 4a. Preoperative appearance of Case 1. Narrowing of the first web space due to post-burn scar tissue with limitation of thumb abduction.

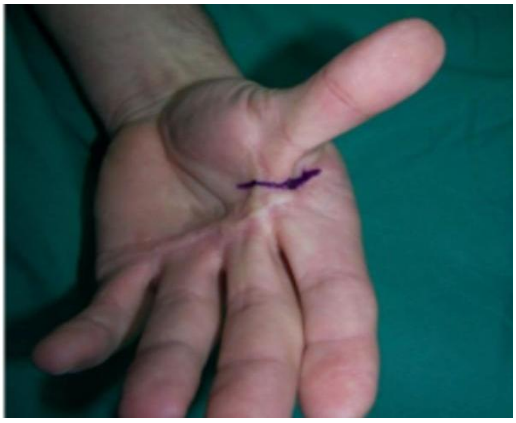


Figure 4b. Early postoperative appearance of Case 1 after complete release and reconstruction with an FDMA-based island flap, demonstrating increased first web space opening.

Complete release of the first web space contracture was achieved in all patients. Reconstruction of the resulting defect was performed with an FDMA-based kite flap in all cases. In one patient, an additional cross-finger flap was used for concomitant fifth-finger contracture correction. A total of six flaps were performed in five patients. Surgical procedures are summarized in Table 2.

Table 1. Demographic and clinical characteristics of patients (n = 5)

Patient no.	Age	Burn etiology	Affected region	Associated deformity
1	22	Stove contact	First web space	None
2	22	Stove contact	First web space	Fifth-finger flexion contracture
3	21	Hot water	First web space	None
4	21	Hot water	First web space	None
5	22	Stove contact	First web space	None

Table 2. Surgical procedures performed and flap distribution

Patient no.	Contracture release	First web reconstruction	Additional procedure	Total flaps
1	Complete	Kite (FDMA) flap	None	1
2	Complete	Kite (FDMA) flap	Cross-finger flap (fifth finger)	2
3	Complete	Kite (FDMA) flap	None	1
4	Complete	Kite (FDMA) flap	None	1
5	Complete	Kite (FDMA) flap	None	1

Early postoperative appearances following contracture release and flap reconstruction demonstrated restoration of web space width and thumb positioning (Figure 4b, Figure 5b).

Figure 5a. Preoperative appearance of Case 2. Narrowing of the first web space due to post-burn scar tissue with an associated fifth-finger flexion contracture.

Figure 5b. Early postoperative appearance of Case 2 after complete release. Reconstruction of the first web space with an FDMA-based island flap and reconstruction of the fifth finger with a cross-finger flap, demonstrating improved web space opening and finger position.

Preoperative first web space opening ranged from 65 to 75. Postoperatively, all patients achieved a first web space opening of 90. The mean preoperative opening was 70.0 (3.5), which increased to 90.0 (0.0), corresponding to a mean absolute improvement of 20.0 (3.5). Individual measurements are presented in Table 3.

Follow-up ranged from 5 to 7 months. The achieved first web space opening was preserved in all patients throughout follow-up, and no residual or recurrent contracture was observed. In the patient who underwent combined reconstruction, improvement in both web space opening and finger position was maintained. Follow-up data are summarized in Table 4.

Table 3. First web space opening measurements

Patient no	Preoperative	Postoperative	Absolute increase
1	70	90	20
2	75	90	15
3	65	90	25
4	70	90	20
5	70	90	20

Table 4. Follow-up duration and early clinical outcomes

Patient no.	Follow-up (months)	Early clinical outcome	Residual contracture
1	7	Web opening maintained	Not observed
2	5	Web opening and finger position maintained	Not observed
3	6	Web opening maintained	Not observed
4	6	Web opening maintained	Not observed
5	6	Web opening maintained	Not observed

Discussion

Post-burn first web space contractures are functionally critical deformities that disproportionately impair hand performance. Narrowing of this region restricts thumb palmar abduction, alters grip geometry, and compromises opponens function, thereby limiting both power and precision grip. Classical hand surgery literature has emphasized that thumb adduction contracture should be viewed not as a localized scar problem, but as a condition with broad biomechanical consequences for the entire hand [1, 2].

Effective surgical management requires both complete release and durable preservation of the achieved opening. This balance is particularly challenging in burn sequelae because scar tissue remains prone to secondary contraction. Classification systems for post-burn first web space contractures highlight the need to tailor surgical strategy according to depth, extent, and tissue deficiency [6]. In the present series, a true soft tissue defect was consistently present after release, supporting the interpretation that these deformities were volume-deficient rather than simple linear scar bands.

The first prerequisite for meaningful correction is complete release of all restricting structures. Limited division of superficial scar bands may leave residual restriction despite reconstruction. Functional recovery depends on restoration of the three-dimensional web space volume rather than surface widening alone. Interposition tissue is therefore essential because it provides volume, redirects tension vectors, and reduces the risk of re-shortening, aligning with Sandzen's volumetric concept of thumb web reconstruction [3]. In burn-related contractures, flap-based reconstruction offers both biological and mechanical advantages over graft-only closure [4, 5].

The FDMA-based kite flap is a well-established local island flap with reliable vascular anatomy and favorable tissue characteristics for first web space reconstruction. Its anatomical basis, described by Foucher and Braun and supported by vascular studies, explains its clinical reliability [16, 17]. The flap provides thin, pliable, well-vascularized tissue that is particularly suited to interposition in a highly mobile region.

In this series, the FDMA flap was used to meet both coverage and volume requirements after complete release. Use of similar local tissue may facilitate integration and improve resistance to secondary contraction. Previous reports support the versatility and practicality of the FDMA flap in post-burn thumb deformities and routine thumb reconstruction [18-20].

In one patient, simultaneous correction of an associated fifth-finger flexion contracture was performed using a cross-finger flap. Addressing multiple deformities in a single session supports the principle that post-burn hand deformities are frequently multifocal and that isolated correction may limit functional recovery [14].

Alternative techniques may be appropriate depending on contracture type. Z-plasty can be effective for superficial linear bands but may be insufficient when tissue deficiency is present [8]. The square flap is a volumetric technique that can expand contracted webs and has been used successfully in selected post-burn cases [9-11]. Skin grafting, although technically simpler, remains vulnerable to secondary contraction in mobile areas; comparative data support greater resistance to re-contracture with flap-based interposition reconstruction than with full-thickness grafting alone [12,13].

In this study, outcome assessment relied on first web space opening, an objective and clinically meaningful measure reflecting thumb positioning and grip span. Restoration and maintenance of this parameter suggest improved palmar abduction and grip geometry. However, web space opening alone does not fully capture hand function. Future studies could incorporate additional measures such as pinch strength and validated functional or patient-reported outcome instruments.

Limitations

This study has limitations. The sample size was small (n=5), limiting generalizability and precluding meaningful comparison with alternative techniques. Follow-up was limited to 5–7 months, which is insufficient to assess long-term recurrence in the setting of ongoing burn scar remodeling. Functional assessment relied on a single measurement parameter without complementary strength testing or patient-reported outcomes. Finally, the absence of a comparator group limits conclusions regarding superiority over other reconstructive options.

Conclusion

This case series suggests that complete release of post-burn first web space contractures followed by reconstruction with an FDMA-based kite flap can restore and maintain functional web space opening in the short to mid-term. The findings support the concept that these contractures should be treated as volume-deficient deformities rather than isolated scar bands and that interposition tissue after adequate release may provide a stable basis for preserving thumb palmar abduction. Larger studies with longer follow-up and broader functional assessment are needed to better define optimal reconstructive strategies.

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J Surg Med. 2026;10(1):7-14.
https://doi.org/10.28982/josam.8381

Research article
https://jsurgmed.com/

JOSAM

Journal of Surgery and Medicine

e-ISSN: 2602-2079

The effect of dietary total antioxidant capacity of individuals with type 2 diabetes on metabolic and oxidative parameters: A cross-sectional study

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Ethics Committee Approval
The study was approved by the Scientific Research and Publication Ethics Committee of Toros University with decision number 170 dated October 26, 2022.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
This study was financially supported by the Toros University (Project no: 2020-SBYO-ÖÖA-1) as a research grant with no role in the design, analysis or writing of this article.

Published
2026 January 6

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Abstract

Background/Aim: The aim of this study is to determine the dietary total antioxidant capacity (DTAC) values and levels of certain serum oxidative parameters in individuals with previously and newly diagnosed type 2 diabetes and to evaluate the impact of these findings on glycemic values and metabolic parameters.
Methods: This study was conducted with a total of 97 participants aged 19-64, comprising 35 individuals with a previous type 2 diabetes diagnosis, 32 individuals with a recent type 2 diabetes diagnosis, and 30 healthy participants. During face-to-face interviews, participants provided descriptive information, physical activity levels, and anthropometric measurements. DTAC was calculated from three-day dietary intake records using various methods. Serum samples were collected for the analysis of glycemic, lipid, and oxidative parameters.
Results: The results show that DTAC values (specifically derived from total radical-trapping antioxidant potential (TRAP) and total phenolics (TP) values)) and serum TAC levels tend to decrease with both prolonged diabetes age and when compared to individuals without diabetes ($P<0.05$). DTAC values were found to have a significant effect on some oxidative parameters like TAC, paraoxonase 1, and arylesterase ($P<0.05$), while serum oxidative parameters were found to have no significant effect on glycemic and lipid parameters.
Conclusion: It was concluded that low DTAC may be a risk factor related to oxidative stress depending on type 2 diabetes and diabetes age.

Keywords: type 2 diabetes, dietary total antioxidant capacity, glycemic control, oxidative parameters, metabolic parameters

How to cite: Akkuş ÖÖ, Mermer M, Gen R, Çimen MBY, Koutelidakis A, Dönmez İ. The effect of dietary total antioxidant capacity of individuals with type 2 diabetes on metabolic and oxidative parameters: A cross-sectional study. J Surg Med. 2026;10(1):7-14.

Introduction

Type 2 diabetes mellitus (DM) is a metabolic disease characterized by hyperglycemia and insulin resistance [1]. DM, which progresses with chronic hyperglycemia, creates an inflammatory environment in the body and creates an important ground for the formation of reactive oxygen derivatives (ROS). The increase in ROS production and the decrease in antioxidant concentrations lead to oxidative stress, which can be associated with elevated plasma glucose levels and complications arising from diabetes [2].

Experimental and clinical studies have shown that oxidative stress (OS) plays an important role in the pathogenesis of type 2 DM. High levels of free radicals and insufficient antioxidant defense mechanisms can damage cellular organelles and enzymes, increase lipid peroxidation, and lead to the development of insulin resistance [3, 4]. While it has been reported that individuals with type 2 DM have decreased total antioxidant capacity and increased levels of oxidative stress biomarkers [5], increasing the intake of common dietary antioxidants has been shown to reduce insulin resistance and promote glycemic improvement [6, 7]. Dietary compounds with antioxidant activity may exert antioxidant effects cumulatively or synergistically [7]. Fruits and vegetables, fatty seeds, wine, tea, and coffee are the foods that contribute the most to the overall antioxidant capacity of the diet [8]. Dietary antioxidants both prevent cellular oxidative damage by preventing excessive free radical formation and alleviate the progression of oxidative stress-induced conditions by preventing cellular degeneration from further progressing after damage [9].

Since assessing antioxidants individually may not provide a complete picture of a diet's overall antioxidant potential and might ignore synergistic interactions, researchers have introduced a cumulative approach known as dietary total antioxidant capacity (DTAC), which evaluates the collective effectiveness of all dietary antioxidants in combating reactive compounds [10, 11]. In studies conducted with different sample groups, the protective role of high DTAC values against oxidative stress has been addressed, and it has been found that high DTAC values may reduce the risk of hypertension, dyslipidemia, and retinopathy in cross-sectional studies [12, 13], while cohort studies have shown an association with lower cancer and cardiovascular risk [14, 15].

Today, there is no gold standard for measuring ROS-mediated tissue damage. Instead of separately evaluating the antioxidant and oxidant effects against antioxidant presence, which is costly, time-consuming, and challenging to measure technically or still undiscovered, it is recommended to measure total antioxidant capacity (TAC) and total oxidant capacity (TOC). Therefore, both TAC and TOC serve as logical approaches to the evaluation of OS [16]. In addition, the Oxidative Stress Index (OSI), which more clearly defines oxidant-antioxidant imbalances in chronic inflammatory diseases, has been developed [17].

Considering the duration of diabetes, no studies evaluating the effects of DTAC values on serum oxidative, glycemic, and lipid parameters in type 2 diabetics have been discovered. The purpose of this study is to determine the DTAC values of individuals with type 2 DM who have been diagnosed either recently or previously, and to evaluate the effects of these findings on glycemic levels and lipid parameters.

Materials and methods

This cross-sectional and comparative case-control study was conducted between October 2022 and March 2023 with a total of 97 individuals, including 35 participants with a previous diagnosis of type 2 diabetes mellitus (with a diabetes duration of at least five years), 32 participants with a recent diagnosis of type 2 diabetes mellitus, and 30 healthy participants. All participants were followed at the Internal Medicine and Endocrinology outpatient clinics of Mersin University Faculty of Medicine. The inclusion criteria for healthy individuals participating in the study required that they present to the hospital for routine checks, have no diagnosis of any disease, and fall within the same age range as individuals with type 2 diabetes, while those with inflammatory conditions (such as rheumatoid arthritis) or chronic diseases. Individuals diagnosed with cancer, users of oral antidiabetic agents other than biguanide derivatives, pregnant and lactating women, as well as individuals who smoke or take antioxidant dietary supplements were excluded from the study. For the study to be conducted, ethical approval was obtained from the Scientific Research and Publication Ethics Committee of Toros University with decision number 170 dated October 26, 2022. Written informed consent was obtained from participants before the study commenced. To determine the sample size, a power analysis was conducted using G*Power software with an alpha (α) level of 0.05, power (1-β) of 0.98, and a medium effect size (d=0.50). The analysis determined that a total of 90 observations would achieve an approximate test power of 100% for this study.

In the study, face-to-face interviews were conducted with the individuals to inquire about their descriptive characteristics (age, gender, marital status, education duration) and physical activity status. Anthropometric measurements (body weight, height, waist and hip circumference) were taken. In addition, DTAC values (FRAP1, FRAP2, TRAP, TEAC, H-ORAC, L-ORAC, Total-ORAC, TP values) were calculated by using three-day food consumption records of individuals, two days on weekdays and one day on weekends, and serum samples were taken for serum glycemic (fasting blood glucose (FBG), glycated hemoglobin (A1c)), lipid (total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides) and oxidative parameters (TAC, TOC, PON-1, ARES).

Anthropometric measurements

Body weight, height, waist and hip circumference measurements were taken during face-to-face interviews [18]. BMI values (body weight (kg)/height (m^2)) were calculated using body weight and height measurements and evaluated according to the World Health Organization (WHO) classifications (BMI: <18.5 kg/m^2 is weak, between 18.5-24.9 kg/m^2 is normal, between 25.0-29.9 kg/m^2 is overweight, ≥30.0 kg/m^2 is obese) [19]. In addition, the waist-hip ratio was calculated by proportioning the waist and hip circumference measurements, and the waist-hip ratio was calculated by proportioning the height measurements. The individuals' waist-to-height ratios were classified according to the classification developed by Ashwell et al. [20] (<0.5 normal, 0.5-0.6 risk, and ≥0.6 high risk), while the waist-to-hip ratios were assessed based on WHO criteria (waist-to-hip ratio: men: <0.9; women: <0.85) [21].

Calculation of total antioxidant capacity of diets

In calculating the total antioxidant capacity of diets, three different databases were utilized to assess the ferric-reducing antioxidant power (FRAP), Trolox equivalent antioxidant capacity (TEAC), total radical-trapping antioxidant potential (TRAP), and oxygen radical absorbance capacity (ORAC) of the foods [22-24]. The estimated FRAP values according to the database created by Carlsen et al. [22] were named FRAP-1 analysis, and the FRAP values estimated according to the database created by Pellegrini et al. [23, 24] were named FRAP-2. According to the database created by the United States Department of Agriculture (USDA), ORAC values were evaluated by hydrophilic-ORAC (H-ORAC), lipophilic-ORAC (L-ORAC), total-ORAC and total Phenolics (TP) analyses [25]. When calculating the total antioxidant capacity of the diets, the FRAP1, FRAP2, TRAP, TEAC, H-ORAC, L-ORAC, Total-ORAC, and TP values for each food item listed in the databases were defined in the Nutrition Information System (BeBİS) program [26], and 24-hour feedback from individuals was collected by dieticians, one day in person and one day by telephone. The dieticians used the BeBiS program to determine the average daily total antioxidant capacity of their diets from their two-day food consumption records. In cases where DTAC values could not be determined, the values of the nutrients with the most similarities were taken.

Biochemical parameters

In the study, measurements of FBG, A1c, total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides were conducted on serum samples obtained after a 12-hour fasting period during routine analyses. Serums obtained after centrifugation from blood samples were portioned into eppendorf tubes and stored at -20°C until analysis to evaluate TAC, TOC, paraoxanase 1 (PON1), and arylesterase (ARES) enzyme activity levels. The analysis of these samples, gradually solubilized, was performed using a spectrophotometric method with an automatic microplate reader (Mindray BS300), employing suitable local commercial kits (RelAssay® Diagnostics, Diagen, Ankara). The formula OSI =TOS/(TAS×100) was used to calculate the oxidative stress index (OSI) [17].

Statistical analysis

During the statistical analysis phase of the study, the relationships between categorical variables (*n* x *r*) were examined; in cases where at least one of the expected values of the cells was less than five, the Fisher test was applied, while the Pearson chi-square test of independence was used when all cells were greater than five. The skewness and kurtosis values of the variables were calculated on a group basis, and it was observed that these values fell within the range indicating suitability for normal distribution. Therefore, parametric tests were preferred in the study. The independent samples t-test was used to compare the means between two quantitative variables, while the independent samples ANOVA test was used to compare the means between three groups. Multiple comparisons were examined with the Tukey test in cases where the significance values were less than 0.05 in the ANOVA test. In the later stage of the study, logistic regression analysis was applied to examine the effects of independent variables on dependent variables. In logistic regression analysis, independent (quantitative) variables were divided into two groups, high and low, according to their median values prior to being used in the model. In all calculations and interpretations, the statistical significance level was considered as $P<0.05$. Statistical analysis of the data was performed using R software [27] and the IBM SPSS 26 statistical package program [28].

Results

The distribution of the general characteristics of the study participants is presented in Table 1. While no significant relationship was found between the mean age of the participants in the study, it was determined that individuals with a previous diagnosis of type 2 diabetes had shorter education durations, whereas the control group had longer education durations compared to the other groups ($P<0.001$). In terms of gender distribution, analysis showed that among individuals with a previous diagnosis of type 2 diabetes, females comprised 68.6%, while males constituted 56.2% of those with a new diagnosis ($P<0.001$). However, the rate of individuals with type 2 diabetes with a family history of the disease (82.9%) was higher than those with newly diagnosed type 2 diabetes (59.4%) ($P<0.001$). Evaluation of individuals with type 2 diabetes in terms of treatment methods showed that the rate of those treated with diet and oral antidiabetic drugs (OAD) (71.4%; 65.6%, respectively) and the rate of those receiving diet and insulin treatment (28.6%; 18.8%, respectively) was higher in individuals with both previously and newly diagnosed type 2 diabetes. However, it was determined that the rate of those treated with diet alone (15.6%) among individuals with newly diagnosed type 2 diabetes was lower than other treatment methods ($P<0.001$). According to the findings, it was determined that the waist/hip ratios, waist/height ratios, and BMI values of the participants in the control group were significantly lower than those of individuals with previously diagnosed type 2 diabetes ($P<0.001$) (Table 1).

There was no statistically significant difference between the FRAP1, TEAC, H-ORAC, L-ORAC, Total ORAC, TOC, PON-I and OSI values of the individuals with type 2 diabetes and the individuals in the control group. In addition, it was determined that the TRAP and TP values of the previously diagnosed type 2 diabetic individuals were significantly lower than both the control group ($P=0.004$) and the newly diagnosed type 2 diabetic individuals ($P=0.003$), and the FRAP2 values were significantly lower than the control group only ($P=0.005$). It was further determined that the levels of FBG, A1c, and LDL-K in the control group were significantly lower than in the other groups. The total cholesterol level was significantly lower only when compared to individuals newly diagnosed with type 2 diabetes ($P<0.001$), while the HDL cholesterol level was higher than in the other groups (previous diagnosis $P=0.002$; new diagnosis $P=0.01$). It was shown that the TAC levels of individuals with a previous diagnosis of type 2 diabetes were also significantly lower than those of both the newly diagnosed type 2 diabetes and the control group ($P<0.001$), while the ARES levels decreased significantly based on the ranking of previous diagnosis, new diagnosis, and control groups ($P<0.001$) (Table 2).

Table 1: Comparison of general and anthropometric characteristics of individuals participating in the study

Variables	Previous Diagnosis (n=35)	New Diagnosis (n=32)	Control Group (n=30)	*P*	*P1*	*P2*	*P3*
Age (year)	43.9 (7.3)	41.3 (10.8)	39.7 (7.4)	0.770[A]	0.853	0.562	0.879
Gender				<0.001[C]**			
Male	11 (31.4%)	18 (56.2%)	3 (10%)				
Female	24 (68.6%)	14 (43.8%)	27 (90%)				
Duration of education (year)	8.9 (4.1)	8.3 (5.2)	15.8 (3.6)	<0.001[A]**	0.046*	<0.001**	<0.001**
Family history of DM				<0.001[F]**			
Yes	6 (17.1%)	13 (40.6%)	30 (100%)				
No	29 (82.9%)	19 (59.4%)	0 (0%)				
Additional diseases							
Obesity	15 (42.9%)	12 (37.5%)	1 (3.3%)	<0.001[F]**			
Hypertension	15 (42.9%)	10 (31.3%)	0 (0%)	<0.001[F]**			
CVD	5 (14.3%)	8 (25.0%)	0 (0%)	0.010[F]**			
Kidney defects	1 (2.9%)	2 (6.3%)	0 (0%)	0.522[F]			
Eye diseases	3 (8.6%)	1 (3.1%)	0 (0%)	0.322[F]			
Thyroid diseases	7 (20.0%)	5 (15.6%)	0 (0%)	0.023[F]*			
Treatment method				<0.001[F]**			
Diet	0 (0%)	5 (15.6%)	0 (0%)				
Diet + OAD	25 (71.4%)	21 (65.6%)	0 (0%)				
Diet + insulin treatment	10 (28.6%)	6 (18.8%)	0 (0%)				
Regular diet				0.498[F]			
Yes	5 (14.3%)	3 (27.3%)	0 (0%)				
Occasional	17 (48.6%)	3 (27.3%)	0 (0%)				
No	13 (37.1%)	5 (45.5%)	1 (100%)				
Waist/hip ratio	0.95 (0.10)	0.92 (0.10)	0.89 (0.10)	<0.001[A]**	0.419	<0.001**	0.146
Waist/height ratio	0.62 (0.10)	0.61 (0.10)	0.59 (0.10)	<0.001[A]**	0.993	<0.001**	0.804
BMI (kg/m²)	31.2 (4.9)	30.2 (6.5)	28.8 (5.3)	<0.001[A]**	0.753	<0.001**	0.465
Energy intake (kcal)	1657.9 (447.6)	1799.1 (715.1)	1859.2 (412.3)	0.306[A]			
Physical activity level	1.65 (0.32)	1.69 (0.13)	1.73 (0.14)	0.596[A]			

P: Overall significance; *P*1: New diagnosis vs Previous diagnosis; *P*2: Control vs Previous diagnosis; *P*3: Control vs New diagnosis; A: ANOVA; C: Chi-square test; F: Fisher's exact test; DM: Diabetes Mellitus; OAD: Oral Antidiabetic Drug; BMI: Body Mass Index; CVD: Cardiovascular Disease. **P*<0.05, ***P*<0.01, ****P*<0.001

Table 2: Dietary total antioxidant capacities and biochemical parameters of the individuals participating in the study

Variables	Previous Diagnosis (n=35)	New Diagnosis (n=32)	Control Group (n=30)	*P*	*P1*	*P2*	*P3*
FRAP1	7.6 (3.5)	9.9 (7.3)	8.4 (3.8)	0.206	0.183	0.809	0.516
FRAP2	2.0 (1.0)	2.4 (1.4)	2.9 (1.2)	0.008*	0.343	0.005*	0.179
TRAP	55.6 (47.8)	78.2 (88.7)	77.4 (46.5)	0.003*	0.003*	0.004*	0.898
TEAC	60.7 (52.3)	64.7 (58.0)	67.2 (37.2)	0.870	0.943	0.862	0.979
H-ORAC	15512.6 (6290.5)	19789.6 (10434.3)	18517.9 (6541.4)	0.083	0.077	0.288	0.805
L-ORAC	2219.1 (2701.0)	2895.5 (5467.5)	3561.9 (4275.2)	0.480	0.800	0.811	0.446
Total ORAC	18596.5 (9966.1)	22618.0 (11041.9)	22282.3 (9085.6)	0.198	0.238	0.310	0.991
TP	1116.9 (435.3)	1524.4 (789.8)	1696.1 (669.6)	<0.001**	0.029*	<0.001**	0.546
FBG (mmol/L)	8.7 (3.7)	9.2 (5.0)	5.2 (0.4)	<0.001**	0.804	<0.001**	<0.001**
A1c (%)	7.3 (1.5)	7.7 (2.1)	5.3 (0.5)	<0.001**	0.168	<0.001**	<0.001**
Total-K (mg/dL)	201.2 (52.3)	227.5 (44.1)	180.9 (43.2)	<0.001**	0.071	0.194	<0.001**
LDL-K (mg/dL)	121.5 (37.7)	134.8 (41.1)	91.7 (35.2)	<0.001**	0.360	0.006*	<0.001**
HDL-K (mg/dL)	50.6 (11.3)	52.3 (11.7)	61.6 (14.5)	<0.001**	0.846	0.002*	0.012*
Triglyceride (mg/dL)	195.4 (199.6)	210.7 (132.8)	93.0 (51.6)	0.003*	0.903	0.015*	0.005*
TAC (mmol/L)	1.5 (0.2)	1.6 (0.2)	1.7 (0.2)	<0.001**	<0.001**	<0.001**	0.861
TOC (μmol/L)	6.4 (4.1)	5.9 (1.9)	5.2 (2.3)	0.269	0.852	0.245	0.541
PON-1 (U/L)	322.6 (198.9)	319.4 (205.4)	323.1 (227.4)	0.997	0.998	1.000	0.997
ARES (μmol/L)	626.1 (91.8)	579.9 (64.7)	481.9 (36.1)	<0.001**	<0.001**	<0.001**	0.021*
OSI	0.4 (0.2)	0.4 (0.1)	0.4 (0.1)	0.785	0.938	0.766	0.934

P: Overall significance; *P1:* New diagnosis - Previous diagnosis; *P2:* Control - Previous diagnosis; *P3:* Control - New diagnosis; A: ANOVA test; T: Independent samples t-test; Tukey test was used in multiple comparisons; FRAP: Ferric Reducing Antioxidant Activity; TEAC: Trolox Equivalent Antioxidant Capacity; TRAP: Total Radical Capture Antioxidant Potential; H-ORAC: Hydrophilic Oxygen Radical Absorption Capacity; L-ORAC: Lipophilic Oxygen Radical Absorption Capacity; TP: Total Phenolics; FBG: Fasting Blood Glucose; A1c: Glycated Hemoglobin; Total Cholesterol: Total-K; LDL-K: Low Density Lipoprotein; HDL-K: High Density Lipoprotein; TAC: Total Antioxidant Capacity; TOC: Total Oxidant Capacity; PON-1: Paraoxonase 1; ARES: Arylesterase; OSI: Oxidative Stress Index; **P*<0.05, ***P*<0.01, *P*<0.001

Linear regression models showing the effect of the dietary antioxidant capacities of the individuals participating in the study on their blood oxidative parameters are presented in Table 3. Findings from individuals with previous type 2 diabetes indicated that only the TRAP value had a significant effect on ARES level (*P*=0.004). Upon examining this effect, it was determined that a high TRAP value decreased the ARES level by 108.885 units compared to a low TRAP value. In individuals newly diagnosed with type 2 diabetes, FRAP1, FRAP2, TRAP, TEAC, H-ORAC, L-ORAC, and Total ORAC values did not have a statistically significant effect on TAC, PON-1, and ARES levels. However, FRAP1, and TEAC values exerted a substantial effect on TOC and OSI (respectively *P*=0.03, *P*=0.05; *P*=0.03, *P*=0.04). When this effect was examined, it was found that the high FRAP1 value increased the TOC level by 3.499 units and the OSI level by 0.220 units compared to the low FRAP1 value, while the high TEAC group decreased the TOC level by 3.874 units and the OSI level by 0.252 units compared to the low TEAC group. In the control group, the Total ORAC value was found to have a significant effect on TAC level, TEAC value on PON-1 level, and L-ORAC values on the ARES level (respectively *P*=0.02; *P*=0.01; *P*=0.02). When these effects were examined individually, it was seen that a high Total ORAC value increased the TAC level by 0.280 units compared to a low Total ORAC value; a high TEAC value increased the PON-1 level by 426.534 units compared to a low TEAC value; and a high L-ORAC value increased the ARES level by 36.919 units compared to a low L-ORAC value.

Table 4 shows the linear regression models showing the effect of serum oxidative stress parameters of the study groups on glycemic control and lipid profiles. Considering the values of individuals with previously diagnosed and newly diagnosed type 2 diabetes, it was determined that the levels of TAC, TOC, PON-1, ARES, and OSI did not have a significant effect on the levels of FBG, A1c, LDL-K, HDL-K, and Total-K. Considering the values for individuals with both previously and newly diagnosed type 2 diabetes, it was observed that TAC, TOC, PON-1, ARES, and OSI levels did not significantly affect FBG, A1c, LDL-C, HDL-C, and Total-C levels. Again, in the control group, PON-1, ARES and OSI values did not have a significant effect on HDL-K

Table 3: Linear regression models showing the effect of dietary antioxidant capacity on blood oxidative parameters

Response	Regressor	Previous diagnosis					New diagnosis					Control group				
		B	P	95%CI		R^2	B	P	95%CI		R^2	B	P	95%CI		R^2
				Lower	Upper				Lower	Upper				Lower	Upper	
TAC	Intercept	1.668	**<0.001**	1.498	1.837	0.097	1.664	**<0.001**	1.499	1.829	0.184	1.545	**<0.001**	1.425	1.665	0.417
	FRAP1 (Ref=Low)	0.009	0.951	-0.298	0.316		0.012	0.947	-0.379	0.355		-0.149	0.141	-0.350	0.053	
	FRAP2 (Ref=Low)	-0.055	0.593	-0.261	0.152		0.043	0.596	-0.123	0.210		-0.064	0.407	-0.222	0.093	
	TRAP (Ref=Low)	0.041	0.705	-0.178	0.259		-0.008	0.950	-0.256	0.241		-0.077	0.587	-0.365	0.211	
	TEAC (Ref=Low)	-0.095	0.448	-0.348	0.158		0.065	0.744	-0.341	0.471		0.095	0.412	-0.140	0.330	
	H-ORAC (Ref=Low)	0.184	0.252	-0.138	0.507		-0.028	0.820	-0.277	0.221		-0.173	0.067	-0.358	0.013	
	L-ORAC (Ref=Low)	0.030	0.791	-0.199	0.259		0.089	0.336	-0.097	0.275		-0.041	0.552	-0.182	0.100	
	Total ORAC (Ref=Low)	-0.109	0.399	-0.370	0.152		-0.191	0.171	-0.471	0.088		0.280	**0.016***	0.059	0.502	
TOC	Intercept	6.453	**<0.001**	3.344	9.561	0.063	5.563	**<0.001**	4.131	6.994	0.285	5.343	**<0.001**	3.432	7.254	0.185
	FRAP1 (Ref=Low)	-0.655	0.813	-6.282	4.972		3.499	**0.032***	0.317	6.680		0.225	0.885	-2.983	3.434	
	FRAP2 (Ref=Low)	-0.634	0.734	-4.422	3.155		0.228	0.747	-1.216	1.673		1.550	0.213	-0.958	4.057	
	TRAP (Ref=Low)	2.029	0.308	-1.976	6.035		2.109	0.055	-0.051	4.268		-1.997	0.376	-6.581	2.587	
	TEAC (Ref=Low)	-0.594	0.795	-5.227	4.040		-3.874	**0.033***	-7.400	-0.348		0.378	0.836	-3.360	4.117	
	H-ORAC (Ref=Low)	0.405	0.889	-5.507	6.316		-0.872	0.413	-3.033	1.289		1.247	0.391	-1.707	4.201	
	L-ORAC (Ref=Low)	0.738	0.721	-3.463	4.939		-0.632	0.427	-2.247	0.983		-0.815	0.460	-3.063	1.434	
	Total ORAC (Ref=Low)	-1.450	0.539	-6.229	3.330		0.350	0.769	-2.078	2.779		-1.050	0.544	-4.581	2.481	
PON-1	Intercept	276.142	**<0.001**	127.555	424.729	0.076	315.872	**<0.001****	146.823	484.920	0.150	182.528	**<0.001**	32.871	332.186	0.476
	FRAP1 (Ref=Low)	-56.362	0.671	-325.333	212.609		-100.096	0.588	-475.839	275.647		-123.528	0.319	-374.808	127.753	
	FRAP2 (Ref=Low)	-46.298	0.604	-227.395	134.799		4.685	0.955	-165.891	175.262		71.284	0.460	-125.093	267.661	
	TRAP (Ref=Low)	88.387	0.352	-103.067	279.841		-115.210	0.361	-370.278	139.859		-317.689	0.080	-676.684	41.307	
	TEAC (Ref=Low)	55.340	0.612	-166.116	276.796		258.230	0.213	-158.240	674.701		426.534	**0.006***	133.754	719.313	
	H-ORAC (Ref=Low)	57.227	0.681	-225.338	339.792		-91.317	0.468	-346.609	163.976		145.787	0.205	-85.559	377.133	
	L-ORAC (Ref=Low)	64.536	0.515	-136.253	265.325		-56.797	0.545	-247.532	133.938		113.531	0.195	-62.561	289.623	
	Total ORAC (Ref=Low)	-72.529	0.520	-300.973	155.915		107.231	0.448	-179.635	394.096		-39.627	0.769	-316.183	236.929	
ARES	Intercept	611.942	**<0.001**	556.797	667.088	0.402	564.442	**<0.001**	511.046	617.837	0.144	476.432	**<0.001**	451.167	501.697	0.404
	FRAP1 (Ref=Low)	87.104	0.085	-12.720	186.928		14.156	0.808	-104.526	132.837		16.818	0.420	-25.602	59.239	
	FRAP2 (Ref=Low)	13.130	0.692	-54.081	80.342		47.200	0.083	-6.678	101.078		11.243	0.489	-21.909	44.395	
	TRAP (Ref=Low)	-108.885	**0.004***	-179.940	-37.830		1.730	0.965	-78.835	82.295		-35.129	0.242	-95.734	25.476	
	TEAC (Ref=Low)	73.492	0.078	-8.698	155.682		-15.778	0.807	-147.324	115.767		-13.311	0.582	-62.737	36.116	
	H-ORAC (Ref=Low)	-67.069	0.200	-171.938	37.800		3.898	0.921	-76.738	84.534		21.248	0.271	-17.807	60.304	
	L-ORAC (Ref=Low)	-19.426	0.597	-93.945	55.094		-9.254	0.754	-69.499	50.991		36.919	**0.017***	7.191	66.646	
	Total ORAC (Ref=Low)	49.099	0.245	-35.684	133.882		-13.848	0.755	-104.456	76.761		-27.603	0.233	-74.291	19.085	
OSI	Intercept	0.388	**<0.001**	0.206	0.570	0.041	0.346	**<0.001**	0.248	0.444	0.301	0.347	**<0.001**	0.212	0.482	0.206
	FRAP1 (Ref=Low)	-0.031	0.850	-0.361	0.299		0.220	**0.047***	0.003	0.437		0.057	0.605	-0.170	0.285	
	FRAP2 (Ref=Low)	-0.021	0.847	-0.243	0.201		-0.006	0.894	-0.105	0.092		0.130	0.142	-0.047	0.308	
	TRAP (Ref=Low)	0.090	0.441	-0.145	0.324		0.123	0.097	-0.024	0.271		-0.117	0.463	-0.441	0.208	
	TEAC (Ref=Low)	-0.002	0.987	-0.274	0.270		-0.252	**0.041***	-0.493	-0.011		0.005	0.972	-0.260	0.269	
	H-ORAC (Ref=Low)	-0.019	0.909	-0.366	0.327		-0.044	0.548	-0.191	0.104		0.114	0.269	-0.095	0.324	
	L-ORAC (Ref=Low)	0.034	0.776	-0.212	0.281		-0.061	0.263	-0.172	0.049		-0.047	0.543	-0.207	0.112	
	Total ORAC (Ref=Low)	-0.055	0.691	-0.335	0.225		0.069	0.398	-0.097	0.235		-0.138	0.265	-0.388	0.112	

B: Regression coefficient, CI: Confidende interval, R^2: Coefficient of determination, Ref: Reference group; FRAP: Ferric Reducing Antioxidant Activity; TEAC: Trolox Equivalent Antioxidant Capacity; TRAP: Total Radical Capture Antioxidant Potential; H-ORAC: Absorbing Capacity of Hydrophilic Oxygen Radical; L-ORAC: Absorbing Capacity of Lipophilic Oxygen Radical; TP: Total Phenolics.; TAC: Total Antioxidant Capacity; TOC: Total Oxidant Capacity; PON-1: Paraoxanase 1; ARES: Arylesterase; OSI: Oxidative Stress Index; *P<0.05, **P<0.01, P<0.001

Table 4: Linear regression models showing the effect of serum oxidative stress parameters on glycemic control and cholesterol values

Response	Regressor	Previous diagnosis					New diagnosis					Control group				
		B	P	95% CI		R^2	B	P	95% CI		R^2	B	P	95% CI		R^2
				Lower	Upper				Lower	Upper				Lower	Upper	
FBG	Intercept	149.745	**<0.001**	81.488	218.002	0.130	130.395	**0.013**	29.987	230.804	0.047	92.021	**<0.001**	85.730	98.311	0.176
	TAC (Ref=Low)	-22.347	0.435	-80.141	35.447		24.379	0.533	-54.889	103.647		1.466	0.696	-6.184	9.116	
	TOC (Ref=Low)	32.465	0.289	-28.956	93.887		-37.602	0.499	-150.307	75.104		3.867	0.334	-4.230	11.963	
	PON-1 (Ref=Low)	-6.407	0.791	-55.310	42.497		10.207	0.781	-64.341	84.756		-4.966	0.148	-11.827	1.894	
	ARES (Ref=Low)	35.787	0.135	-11.788	83.361		35.444	0.359	-42.591	113.480		0.870	0.764	-5.047	6.786	
	OSI (Ref=Low)	-28.535	0.403	-97.337	40.267		35.027	0.530	-78.179	148.234		0.833	0.837	-7.437	9.102	
A1c	Intercept	7.028	**<0.001**	5.559	8.497	0.186	6.314	**<0.001**	4.112	8.516	0.168	5.171	**<0.001**	4.827	5.515	0.389
	TAC (Ref=Low)	-0.374	0.543	-1.618	0.870		-0.065	0.940	-1.803	1.674		0.420	0.049	0.002	0.838	
	TOC (Ref=Low)	-0.220	0.736	-1.542	1.102		1.940	0.119	-0.531	4.412		0.333	0.134	-0.110	0.775	
	PON-1 (Ref=Low)	-0.622	0.236	-1.675	0.430		0.461	0.567	-1.174	2.096		-0.436	**0.024***	-0.811	-0.062	
	ARES (Ref=Low)	0.743	0.149	-0.281	1.767		1.103	0.197	-0.608	2.815		-0.086	0.588	-0.409	0.237	
	OSI (Ref=Low)	0.420	0.567	-1.061	1.900		-0.774	0.527	-3.257	1.708		0.086	0.698	-0.366	0.538	
LDL-K	Intercept	103.541	**<0.001**	66.413	140.668	0.085	133.585	**<0.001**	90.515	176.655	0.158	87.836	**<0.001**	58.049	117.624	0.232
	TAC (Ref=Low)	2.888	0.852	-28.548	34.325		4.086	0.807	-29.915	38.088		10.977	0.538	-25.247	47.202	
	TOC (Ref=Low)	-4.608	0.780	-38.018	28.801		24.687	0.304	-23.657	73.032		11.952	0.526	-26.386	50.291	
	PON-1 (Ref=Low)	-16.861	0.205	-43.461	9.740		-4.832	0.759	-36.809	27.145		9.710	0.543	-22.776	42.195	
	ARES (Ref=Low)	-9.703	0.449	-35.581	16.174		-18.791	0.259	-52.264	14.682		22.004	0.118	-6.011	50.019	
	OSI (Ref=Low)	5.524	0.765	-31.900	42.949		-1.627	0.946	-50.186	46.933		9.763	0.612	-29.395	48.921	
HDL-K	Intercept	48.441	**<0.001**	37.486	59.397	0.222	55.323	**<0.001**	42.915	67.732	0.134	52.004	**<0.001**	41.358	62.650	0.338
	TAC (Ref=Low)	6.619	0.155	-2.657	15.895		-1.682	0.727	-11.477	8.114		15.033	**0.025***	2.086	27.979	
	TOC (Ref=Low)	-4.930	0.315	-14.789	4.928		10.389	0.137	-3.539	24.316		-14.778	**0.036***	-28.480	-1.076	
	PON-1 (Ref=Low)	4.899	0.212	-2.950	12.748		0.801	0.860	-8.412	10.013		0.175	0.975	-11.435	11.785	
	ARES (Ref=Low)	-6.592	0.088	-14.228	1.044		-5.169	0.281	-14.812	4.474		6.956	0.165	-3.056	16.968	
	OSI (Ref=Low)	3.838	0.483	-7.205	14.881		-10.093	0.150	-24.083	3.896		10.855	0.123	-3.140	24.849	

B: Regression coefficient, CI: Confidende interval, R^2: Coefficient of determination, Ref: Reference group; FBG: Fasting Blood Glucose; A1c: Glycated Hemoglobin; Total-K: Total Cholesterol; LDL-K: Low Density Lipoprotein; HDL-K: High Density Lipoprotein; TAC: Total Antioxidant Capacity; TOC: Total Oxidant Capacity; PON-1: Paraoxanase 1; ARES: Arylesterase; OSI: Oxidative Stress Index; *P<0.05, **P<0.01, P<0.001

level, while TAC and TOC levels had a significant effect on HDL-K level (respectively P=0.03; P=0.04). Accordingly, it was found that the high TAC level increased the mean HDL-K level by 15.033 units compared to the low TAC level, while the high TOC level decreased the HDL-K level by 14.778 units compared to the low TOC level.

Discussion

In this study, it was found that DTAC values and serum TAC levels in individuals with type 2 diabetes tend to decrease both with increasing diabetes duration and compared to non-diabetic individuals, while DTAC values have a significant effect on certain oxidative parameters, and serum oxidative parameters do not have an effect on glycemic and lipid parameters.

Oxidative stress occurs as a result of the imbalance between ROS production and destruction and is shown as a potential predictor of both type 2 diabetes and the risk of complications [29, 30]. Conversely, chronic hyperglycemia creates a risk factor for ROS formation, causing type 2 diabetes to deepen and increase the likelihood of complications [31]. The effect of hyperglycemia in ROS accumulation can occur in different ways. The most effective factor is suggested to be the increased use of the glycolytic pathway due to rising hyperglycemia, which, in turn, leads to an accumulation of ROS through heightened electron pressure on the mitochondrial electron transport system [32]. Another way is that increased ROS production is linked to insulin resistance and plays a role in β-cell dysfunction by providing pancreatic β-cell apoptosis [33, 34]. ROS accumulation due to increased hyperglycemia also plays an important role in the formation of diabetes complications [34]. Serum TOC and TAC, which measure the synergistic and cumulative effects of all oxidants and antioxidants, are known to be associated with type 2 diabetes [35]. Although ROS levels rise in individuals with type 2 diabetes with increased diabetes duration, serum antioxidant levels may increase, decrease, or remain the same [35-39]. In this study, in accordance with the work of Kharroubi et al. [39], it was concluded that the serum TAC levels of individuals with a previous diagnosis of type 2 diabetes were lower compared to those in the newly diagnosed and control groups (Table 2). It was further determined that serum TAC levels had no effect on glycemic biomarkers and lipid profile (Table 4). In addition to practical methods that measure total oxidant and total antioxidant levels in serum, PON1 and ARES enzymes are also enzymes that are encoded by the same gene and act as antioxidants in the esterase group with similar active centers. Although it is known that PON1 shows a polymorphic change, the ARES enzyme does not show a genetic polymorphic change. The PON1 enzyme also has antioxidant function due to its ability to protect LDL cholesterol from oxidation and its capacity to neutralize other radicals, including hydrogen peroxide. ARES, in contrast, is accepted as an indicator of the main protein that is not affected by the changes in PON1 [40]. Conditions that increase oxidative stress such as diabetes, hypercholesterolemia, and cardiovascular diseases may cause low PON1 activity due to increased oxidative stress [32]. Therefore, monitoring trends in complications through PON1 may play an important role in the treatment of individuals with type 2 diabetes [33]. In the group of patients with diabetic complications, levels of FBG and TG were found to be higher compared to the control group, while levels of HDL-K and PON1 were lower. It was also reported that HDL-K in individuals with complications of type 2 diabetes is positively correlated with PON1. In the present study, although there was no difference between the groups in PON1 levels (Table 2), it was observed that a one-unit increase in PON1 level only in the control group provided a 0.436-unit decrease in A1c level (Table 4). Another significant outcome of the study is that serum ARES levels were significantly higher in previously diagnosed type 2 diabetes patients compared to both the newly diagnosed and the control group (Table 2). This finding, which differs from the literature, can be interpreted as the endogenous high production of free oxygen radicals due to increased inflammation associated with the duration of diabetes to mitigate their effects [41].

Mechanisms that increase oxidative stress in diabetes include non-enzymatic glycosylation, autoxidative glycosylation, sorbitol pathway activity, hypoxia, and various changes in the antioxidant defense system. There are increases in lipid peroxidation products in the serum and tissues of individuals with diabetes [42]. Dietary antioxidants, however, can play a protective role against type 2 diabetes by increasing the formation of free radicals in type 2 diabetes and reducing radical binding systems [43]. In a study conducted with individuals with type 2 diabetes, where DTAC values were determined through TRAP, FRAP, and TEAC analyses, it was found that the DTAC values of individuals with type 2 diabetes were lower than those of the healthy group, and there was a negative correlation between DTAC values and glycemic biomarkers [44]. Similarly, in a recent cohort study by Mancini et al. [45], higher DTAC values were associated with a lower risk of type 2 diabetes. In a study conducted by Schaft et al. [46] on individuals with type 2 diabetes, it was reported that individuals with type 2 diabetes had lower FRAP values than the control group, and in addition, it was observed that the FRAP values of the group with higher diabetes age were statistically lower than the newly diagnosed group. According to the results of this study, it was observed that the DTAC values of individuals with a previous diagnosis of type 2 diabetes were at a lower level compared to both the newly diagnosed and the control group, while among these markers, TRAP and TP values were statistically significantly lower than both groups, and the FRAP2 value was statistically significantly lower than the control group only (Table 2). In light of these results, it can be stated that as the duration of diabetes increases, the depletion of total dietary antioxidant capacity also increases. Additionally, it was found that the increase in TEAC values in newly diagnosed type 2 diabetics led to a decrease in TOC and OSI levels, while in the control group, the Total ORAC values caused an increase in TAC levels, TEAC values caused an increase in PON-1 levels, and L-ORAC values increased ARES levels (Table 3). These results are consistent with results from numerous studies examining the ability of a DTAC-rich diet to regulate serum TAC status with the consumption of tea, coffee, nuts, fruits, and vegetables [47-50].

Limitations

To the best of our knowledge, this study is one of the first to evaluate the effects of DTAC values obtained from different databases on serum oxidative, glycemic, and lipid parameters between newly diagnosed and previously diagnosed type 2 diabetics and a healthy control group, which constitutes a strong aspect of the study. However, the study also has limitations that should be acknowledged. The first is that the cross-sectional design of the study prevents causal inferences, along with the small sample size. Another limitation is that although the study categorized the groups considering the age of diabetes concerning oxidative mechanisms, the effects of complications were not evaluated.

Conclusion

In conclusion, it was found that the total DTAC values and serum TAC levels of individuals with type 2 diabetes tend to decrease with increasing diabetes age, as well as in comparison to those without diabetes. It was also determined that DTAC values have a significant effect on some oxidative parameters, while serum oxidative parameters do not affect glycemic and lipid parameters. This can be seen as a risk factor in type 2 diabetes, which is associated with increased oxidative stress. In order to provide more comprehensive recommendations on this subject, the effects of DTAC values and oxidative parameters on the complications of type 2 diabetes should be evaluated in a larger sample. However, it is recommended that a sufficient and balanced diet rich in antioxidants be adopted by both individuals with type 2 diabetes and healthy individuals to prevent the development of type 2 diabetes at the community level. Dietary recommendations should be developed in this context to be implemented in public health strategies.

Acknowledgements

We would like to thank all the individuals who participated in our study for their cooperation.

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J Surg Med. 2026;10(1):15-19.
https://doi.org/10.28982/josam.8505

JOSAM
Journal of Surgery and Medicine
e-ISSN: 2602-2079

Research article
https://jsurgmed.com/

Clinical outcomes of lateral digital flap–based local flap combinations in the reconstruction of post-burn metacarpophalangeal joint contractures

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Abstract

Background/Aim: Post-burn metacarpophalangeal (MCP) joint contractures may severely impair hand function due to scar formation involving the palmar surface and volar digital skin. This study aimed to evaluate the clinical and functional outcomes of local flap combinations based on the lateral digital flap for the reconstruction of post-burn MCP joint contractures.

Methods: This retrospective case series included nine male patients who underwent surgical treatment for post-burn MCP joint contractures between May 2010 and April 2011. A total of 48 local flaps were applied in various combinations according to contracture localization and defect characteristics. The lateral digital flap was used as the primary reconstructive method, rhomboid flaps were used for web space reconstruction, and five-flap Z-plasty was applied selectively for deformities involving the palmar surface and/or first web space. All flaps were designed before contracture release, and dissections were performed under tourniquet control with magnification. Clinical outcomes were assessed using postoperative extension deficit and follow-up duration (months).

Results: All patients had contractures at the MCP joint level, with concomitant web space involvement in some cases. Complete restoration of MCP joint extension was achieved in eight patients. One patient had a 10° extension deficit localized to the proximal interphalangeal joint rather than the MCP joint. Follow-up ranged from 1 to 10 months. No flap loss or major postoperative complications were observed during follow-up.

Conclusion: Local flap combinations based on the lateral digital flap constitute a biomechanically compatible, reliable, and functionally effective reconstructive option for post-burn MCP joint contractures in the early to mid-term period. In patients with multiple MCP joint contractures accompanied by web space deformities, combining the lateral digital flap with rhomboid flaps and/or five-flap Z-plasty allows comprehensive correction within a single surgical session.

Keywords: burn sequelae; MCP joint contracture; lateral digital flap; local flap reconstruction; Z-plasty

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Ethics Committee Approval
Written informed consent was obtained from all patients for surgical treatment and the use of clinical photographs. Ethical approval was obtained from the institutional Ethics Committee before study initiation.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 January 14

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How to cite: Melikoglu C. Clinical outcomes of lateral digital flap–based local flap combinations in the reconstruction of post-burn metacarpophalangeal joint contractures. J Surg Med. 2026;10(1):15-19.

Introduction

Deep burns involving the hand may lead to long-term functional sequelae that extend well beyond superficial scar formation. Hand function depends on a precise balance between soft tissue elasticity, joint mobility, and coordinated tendon gliding. When the palmar surface and volar digital skin are affected by burn injury, post-burn scarring progressively alters this balance. The skin–subcutaneous tissue complex gradually loses pliability and behaves as a shortening sheath, forming contracture bands that cross joints and restrict motion. When such contractures involve the metacarpophalangeal (MCP) joint, the resulting loss of extension may severely compromise grasp, release, and fine motor coordination.

The pathophysiology of post-burn MCP joint contractures is multifactorial. In addition to skin involvement, deeper structures including the joint capsule, ligaments, tendon sheaths, and perivascular connective tissue may contribute to progressive shortening. As a result, superficial release alone is rarely sufficient to restore durable joint motion. Inadequate release or reconstruction with tissue that is poorly matched to joint biomechanics increases the likelihood of recurrence and functional limitation.

Successful post-burn reconstruction is governed by a fundamental principle: restoration of joint motion is meaningful only if the resurfacing tissue can tolerate and sustain that motion. A systematic review focusing on delayed burn reconstruction identified flap failure and contracture recurrence as major determinants of outcome, highlighting the importance of appropriate reconstructive technique selection [1]. In the hand, this selection is particularly critical. Excessive tissue bulk, even when vascular reliability is ensured, may impair fine motor function. Consequently, distant or free flaps—although effective for defect coverage—may not always be optimal for MCP joint reconstruction due to tissue mismatch.

Acellular dermal matrices have been introduced as alternative resurfacing options in burn reconstruction. While their role continues to evolve, their long-term behavior in regions exposed to constant motion and multidirectional tension, such as the MCP joint, remains controversial with respect to durability, cost, and availability [2]. In routine clinical practice, reconstructive decisions are often constrained by local tissue conditions rather than ideal theoretical options. Under these circumstances, local flaps provide a biologically sound and practical solution.

The surgical strategy adopted in this study is based on the premise that reconstruction with tissue similar in thickness, elasticity, and orientation to native skin may enhance functional recovery and reduce secondary contracture. This concept aligns with algorithmic approaches to post-burn contracture management, which emphasize contracture localization, severity, defect size, and tissue quality in surgical planning [3]. Lateral digital flaps have been described as a practical option for post-burn digital flexion contractures, supporting their use as a foundation for MCP-level reconstruction [4]. Accordingly, lateral digital flaps were used as the primary reconstructive option for MCP joint contractures, while rhomboid flaps and five-flap Z-plasty were incorporated to address associated web space and palmar surface deformities. This local flap–based combination strategy allows comprehensive correction of complex deformities within a single operative session.

This study is based on clinical data collected between May 2010 and April 2011 and includes 48 local flap procedures performed in nine patients. The primary objective was to evaluate the functional outcomes of lateral digital flap–centered local flap combinations in the reconstruction of post-burn MCP joint contractures. Given its retrospective case series design, the study aimed to provide clinically relevant insights into surgical planning and outcomes rather than comparative statistical inference. Clear outcome reporting and transparent methodology were prioritized to support clinical interpretability.

Materials and methods

Study design and patient selection

This study was designed as a retrospective observational case series. Patients who underwent surgical treatment for post-burn metacarpophalangeal (MCP) joint contractures between May 2010 and April 2011 were evaluated. A total of nine patients were included, in whom 48 local flaps were applied in various combinations according to contracture localization and defect characteristics. All patients were male, with a median age of 20 years (range not available due to the retrospective data structure).

In most cases, the initial burn injury occurred during childhood, and reconstructive surgery was performed in early adulthood. Surgical intervention had been delayed primarily due to socioeconomic limitations. Delayed reconstruction is clinically relevant, as prolonged contracture maturation is associated with progressive shortening of not only the skin but also deeper structures such as the joint capsule and periarticular tissues [1].

This study was conducted in accordance with the principles of the Declaration of Helsinki and was reported in line with STROBE recommendations for observational studies.

Principles of surgical planning

Preoperative flap planning was performed before contracture release in all cases. Although the final defect configuration becomes fully apparent only after complete release of the contracture band, pre-release flap design provided a structured operative roadmap and facilitated reconstruction. This approach supported coverage with adjacent tissue of appropriate quality and enabled anticipation of tension vectors once joint motion was restored.

The primary reconstructive objective was to achieve coverage using local flaps whenever feasible. Local flaps offer several advantages in burn sequela surgery, including limited donor-site morbidity, feasibility under regional anesthesia, single-stage application, and a lower risk of secondary contracture compared with skin grafts. Moreover, excessive tissue bulk associated with distant or free flaps may negatively affect fine motor performance of the hand. Although thin perforator free flaps have been reported for selected extremity contractures, free flap reconstruction remains associated with increased operative complexity and resource utilization [5].

Applied flap techniques

Three local reconstructive techniques were utilized according to the anatomical distribution and severity of contractures. The lateral digital flap was used as the primary reconstructive option for MCP-level digital contractures. Rhomboid flaps were employed for advancement and deepening of involved web spaces, and five-flap Z-plasty was applied selectively in cases involving the palmar surface and/or the first web space.

The rationale for flap selection was based on hand-specific reconstructive requirements. While free anterolateral thigh flaps have been reported for burn contracture reconstruction in various anatomical regions, including the axilla [6,7], the MCP region requires thin, pliable tissue capable of tolerating constant motion along dynamic tension lines. Large series evaluating long-term outcomes of contracture surgery emphasize that restoration of joint range of motion is the primary objective, while the optimal reconstructive technique depends on anatomical location and tissue requirements [8]. Accordingly, the lateral digital flap served as the cornerstone of reconstruction at the MCP level, complemented by rhomboid flaps and five-flap Z-plasty when additional tissue length or web space correction was required.

Anesthesia, dissection, and contracture release

All procedures were performed under tourniquet control with the aid of surgical magnification. Magnified dissection was used during lateral digital flap elevation to facilitate preservation of neurovascular structures. Complete release of contracture bands was performed as the initial step, and flap elevation was initiated only after full passive joint extension had been achieved. This sequence enabled accurate assessment of the post-release defect and minimized excessive tension on the reconstructive flaps.

Postoperative rehabilitation protocol

Postoperative rehabilitation was considered an integral component of treatment. All patients were managed with a daytime dynamic extension splint for the first two postoperative weeks. Formal physiotherapy was initiated at the end of the third postoperative week. This protocol was intended to preserve surgically achieved extension during the early phase of scar maturation and remodeling [9]. Joint range of motion was monitored clinically using goniometric assessment.

Outcome measures

Clinical outcomes were evaluated using postoperative extension deficit as the primary functional parameter and follow-up duration as a secondary descriptive variable. Extension deficit was recorded in degrees and documented in tabular form. Follow-up duration was recorded in months. No comparative statistical testing was performed due to the descriptive nature of the case series design. The functional relevance of burn-related contractures and their contribution to disability have been discussed in prior clinical literature [9].

Ethical considerations

Ethical approval was obtained from the institutional Ethics Committee. Written informed consent was obtained from all patients for both surgical treatment and publication of clinical photographs.

Results

Patient demographics and clinical background

The study cohort consisted of nine patients, all of whom were male. All burn injuries occurred during childhood, and reconstructive surgery was performed after a prolonged delay, reflecting long-standing post-burn sequelae. The median age at the time of surgery was 20 years (Table 1).

Table 1. Demographic characteristics and burn history

Variable	Findings
Number of patients	9
Sex	Male (100%)
Age at surgery, years	20
Timing of burn injury	Childhood
Time to reconstruction	Delayed

Contracture localization

All patients presented with flexion contractures involving the metacarpophalangeal joints of the second to fifth digits. Additional involvement of the first and adjacent web spaces was observed in several patients, resulting in more complex deformities affecting overall hand span and grasp function (Table 2).

Table 2. Anatomical distribution of contractures

Localization	Number of cases
MCP joints (digits 2–5)	9
First web space	3
Second–fourth web spaces	4

Types and combinations of local flaps

The lateral digital flap was used as the primary reconstructive technique in all patients. In cases with associated web space contractures, rhomboid flaps were used to achieve adequate deepening. Five-flap Z-plasty was applied selectively in deformities involving the palmar surface and/or the first web space to provide additional skin length and redistribute tension. These flap combinations enabled simultaneous correction of multiple anatomical components of deformity within a single operative session (Table 3).

Table 3. Local flap types and indications

Flap type	Indication
Lateral digital flap	MCP-level digital contractures
Rhomboid flap	Web space contractures
Five-flap Z-plasty	Palmar surface and/or first web space

Surgical burden

The number of local flaps required per patient varied, reflecting heterogeneity in contracture severity and anatomical extent. Patients presenting with multiple MCP joint contractures and concomitant web space involvement generally required a greater number of flaps. The number of flaps ranged from 2 to 12, with a mean of 5.3 flaps per patient (Table 4).

Table 4. Number of flaps per patient

Parameter	Value
Minimum	2
Maximum	12
Mean	5.3

Functional outcomes

Postoperative extension deficit was used as the primary functional outcome parameter. Complete restoration of MCP joint extension was achieved in eight patients. One patient demonstrated a residual extension deficit of 10°, localized to the proximal interphalangeal joint rather than the MCP joint, indicating effective correction at the target MCP level (Table 5).

Table 5. Postoperative extension deficit

Extension deficit	Number of cases
0°	8
10° (PIP joint)	1

Follow-up and clinical course

Follow-up duration ranged from 1 to 10 months, representing early to mid-term outcomes. During this period, no flap loss, major wound complications, or clinically evident early recurrence of contracture were observed (Table 6).

Table 6. Follow-up duration

Follow-up period (months)	Number of cases
1–3	3
4–8	5
≥9	1

Correlation with clinical photographs

Representative clinical photographs corroborated the functional findings. Preoperative images demonstrated pronounced MCP joint flexion contractures, whereas postoperative images showed restoration of MCP extension and, when applicable, improved web space depth (Table 7).

Table 7. Correlation between figures and clinical findings

Figure	Clinical condition
Figures 1a–b	Isolated MCP contracture reconstructed with lateral digital flap
Figures 2a–b	Five-flap Z-plasty combined with lateral digital flap
Figures 3a–b	Lateral digital flap combined with rhomboid flap and five-flap Z-plasty

Figure 1a. Preoperative appearance of a flexion contracture involving the palmar region and the second to fifth metacarpophalangeal (MCP) joints following burn injury. Marked limitation of MCP joint extension is observed due to palmar scar tissue.

Figure 1b. Early postoperative appearance of the same patient following contracture release using a lateral digital flap. Restoration of MCP joint extension is evident, with preservation of palmar skin integrity achieved through local flap coverage**.**

Figure 2a. Preoperative appearance of a contracture involving the palmar region and the second to fifth MCP joints after burn injury. Preoperative markings demonstrate the planned five-flap Z-plasty and lateral digital flaps along the contracture line.

Figure 2b. Postoperative appearance of the same patient following contracture release using a combination of five-flap Z-plasty and lateral digital flap. Adequate MCP joint extension is achieved, with improved palmar skin elasticity and preservation of local tissue similarity.

Figure 3a. Preoperative appearance of a severe contracture involving the palmar region and the second to fifth MCP joints following burn injury. Extensive palmar scarring and significant limitation of MCP joint extension are evident.

Figure 3b. Postoperative appearance of the same patient after contracture release using a combination of lateral digital flap, rhomboid flap, and five-flap Z-plasty. Functional MCP joint extension has been restored, the web spaces have been deepened, and palmar skin continuity has been reconstructed using local flaps**.**

Discussion

Post-burn hand contractures represent a major challenge in reconstructive surgery because the deformity often evolves into a multilayered pathology rather than remaining a superficial skin problem. Prolonged scarring may affect not only the skin and subcutaneous tissue but also periarticular structures, compromising joint biomechanics and coordinated hand motion [9]. Scar contractures are common after burn injury, and their prevalence has been summarized in systematic reviews [10]. Contractures involving the metacarpophalangeal (MCP) joint are particularly detrimental, as this joint plays a pivotal role in grasp strength, fine motor coordination, and synchronized digital motion.

This case series suggests that local flap combinations centered on the lateral digital flap can provide reliable early- to mid-term functional outcomes in the reconstruction of post-burn MCP joint contractures. All patients underwent delayed reconstruction, with initial burn injuries sustained during childhood and corrective surgery performed years later. Delayed reconstruction has been associated with recurrence and technical complexity, likely reflecting progressive maturation of scar tissue and shortening of deeper structures [1,11]. Despite this unfavorable context, the absence of flap loss, major complications, or clinically evident early recurrence in this series supports the safety and reliability of the applied local flap strategy.

The preference for a local flap–based approach in this study reflects both biomechanical and functional considerations. Skin grafts, although technically straightforward, are associated with a risk of secondary contracture in joint reconstruction and limited durability in high-motion areas [11]. Free or distant flaps, while effective for defect coverage, may introduce excessive tissue bulk that interferes with fine hand function and tendon gliding [5-7,12]. In contrast, local flaps provide tissue with comparable thickness, elasticity, and orientation, supporting physiological gliding planes and multidirectional motion. The lateral digital flap is particularly suitable for MCP-level defects because it uses adjacent tissue, facilitates preservation of neurovascular bundles, and aligns favorably with the joint's motion vectors [4].

A further strength of the present approach is the deliberate use of flap combinations rather than reliance on a single reconstructive technique. Post-burn MCP joint contractures are frequently accompanied by web space deformities, particularly involving the first web space, which can limit grasp by reducing thumb–index span. In such cases, restoration of MCP extension alone may be insufficient for meaningful functional improvement. Algorithmic approaches to post-burn contracture surgery emphasize correction of all contributing components of deformity, including web space narrowing, to optimize functional outcomes [3].

Functional outcomes in this series were assessed using postoperative extension deficit, a pragmatic and clinically relevant parameter used in burn contracture evaluation [9]. Complete restoration of MCP joint extension was achieved in most patients, and the only residual deficit observed was localized to the proximal interphalangeal joint rather than the MCP joint itself, indicating effective correction at the targeted level.

Postoperative rehabilitation likely contributed to maintenance of surgical gains. Dynamic extension splinting followed by structured physiotherapy is widely regarded as essential during the scar maturation phase to preserve surgically achieved range of motion [9].

Limitations

Several limitations should be acknowledged. The retrospective case series design and small sample size limit generalizability and preclude statistical comparison. In addition, a standardized preoperative severity grading system was not available due to the retrospective data structure, limiting direct comparability with other series. Follow-up was limited to the early to mid-term period; late recurrence, which remains a concern in burn sequela surgery, could not be evaluated [1,11]. These limitations are inherent to many case series and support the need for larger prospective studies with longer follow-up.

Conclusion

Local flap combinations centered on the lateral digital flap constitute a reliable, practical, and functionally effective reconstructive option for post-burn metacarpophalangeal joint contractures. Even in delayed reconstruction, satisfactory restoration of MCP joint extension can be achieved using appropriately selected local tissues. In patients with multiple MCP joint contractures accompanied by web space deformities, combining the lateral digital flap with rhomboid flaps and/or five-flap Z-plasty enables comprehensive correction within a single operative session. Postoperative rehabilitation, including dynamic extension splinting and timely physiotherapy, remains indispensable for maintaining surgically achieved gains. Further studies with larger cohorts and longer follow-up are required to better define long-term durability and recurrence patterns.

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JOSAM
Journal of Surgery and Medicine
e-ISSN: 2602-2079

Red cell distribution width to platelet count ratio as a predictor of severity in acute biliary pancreatitis

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Ethics Committee Approval
The study was approved by the Institutional Review Committee of the Patan Academy of Health Sciences (IRC-PAHS; Ref: PSS2207121658). Written informed consent was obtained from all participants.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 January 13

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Abstract

Background/Aim: Acute biliary pancreatitis (AP) is an inflammatory condition of the pancreas with varying degrees of severity. Early detection of severe disease and timely intervention are crucial for improving outcomes. The red cell distribution width to platelet count ratio (RPR) is a proposed inflammatory marker that may be elevated in severe cases. This study aimed to evaluate the utility of RPR in predicting the severity of AP.
Methods: This cross-sectional analytical study was conducted among 35 patients diagnosed with AP over one year. Patients were categorized into mild acute pancreatitis (MAP) and severe acute pancreatitis (SAP) groups. RPR was calculated upon admission, and outcomes were evaluated at the time of discharge or death.
Results: Of the 35 patients, 14 (40%) had SAP. The mean RPR values for MAP and SAP were 0.05924 and 0.06525, respectively. There were four (11%) in-hospital deaths, all in the SAP group. The mean RPR for patients who died was 0.1291 (0.05208). The AUROC values of RPR for severity, ICU stay, and mortality were 0.609, 0.664, and 0.887, respectively.
Conclusion: RPR can predict in-hospital mortality and ICU stay in patients with AP, but it is not sensitive in predicting the severity of the disease.

Keywords: acute pancreatitis, platelet count, RDW-CV, RPR

How to cite: Acharya K, Prajapati A, Karna E, Bir Maharjan S. Red cell distribution width to platelet count ratio as a predictor of severity in acute biliary pancreatitis. J Surg Med. 2026;10(1):20-23.

Introduction

Acute pancreatitis (AP) is a common cause of hospital admission, and its global incidence continues to rise [1,2]. The disease manifests with a spectrum of severity, from mild, self-limiting forms to severe cases that can lead to multi-organ dysfunction and death [3]. While the overall mortality in AP is reported to range between 3% and 6%, this rate can increase up to 30% in cases of severe acute pancreatitis (SAP) [4]. The primary driver of SAP is an exaggerated systemic inflammatory response, which may lead to organ failure [5].

Timely recognition of disease severity is crucial to reducing mortality and improving clinical outcomes. Early admission to intensive care units (ICUs), organ-specific therapies, and proactive management of complications are essential interventions [3,6,7]. Several biomarkers have been investigated for their potential to predict disease progression, and one such marker is the red cell distribution width to platelet count ratio (RPR). RPR, calculated by dividing the red cell distribution width (RDW) by the platelet count, is considered a reflection of systemic inflammation [8].

This study aims to evaluate the accuracy of RPR as a prognostic marker for disease severity in patients with AP. Findings from this study may help optimize care pathways by guiding decisions on hospital admission, imaging, early ICU transfer, discharge planning, and resource utilization.

Materials and methods

This was a cross-sectional analytical study conducted at the Department of General Surgery, Patan Hospital, from November 2022 to November 2023. Ethical clearance was obtained from the Institutional Review Committee of the Patan Academy of Health Sciences (IRC-PAHS; Ref: PSS2207121658). Written informed consent was obtained from all participants. For patients unable to provide consent due to altered mental status, intubation, or sedation, consent was obtained from a legal guardian. Participants could withdraw at any point without consequence. No additional costs or harm were incurred by any patient.

Data were collected confidentially and stored securely in both physical files and encrypted Excel spreadsheets on a password-protected computer. These records will be preserved for future research and auditing purposes. All identifying patient information was anonymized during dissemination. Patients admitted with a diagnosis of acute biliary pancreatitis within the study period were eligible. Exclusion criteria included alcoholic pancreatitis, pre-existing hematological or coagulation disorders, and withdrawal of consent.

Severity of AP was determined according to the Revised Atlanta Classification (RAC) and categorized as either mild acute pancreatitis (MAP) or severe acute pancreatitis (SAP), which included both moderately severe and severe presentations. RPR was calculated from complete blood count reports at admission using the formula:

RPR=(RDW-CV% / Total Platelet Count [in thousands/μL])

Statistical analysis

For analysis, patients were grouped into MAP and SAP categories. Outcomes were measured as either in-hospital death or discharge. Mortality was defined as death from any cause during hospitalization. ICU admission decisions were at the discretion of the attending physician.

Data entry and statistical analysis were performed using Microsoft Excel and MedCalc (v20.104). Variables were tested for normality using the Shapiro-Wilk test. Normally distributed data were reported as mean (standard deviation), while skewed data were expressed as median with interquartile range. Mann-Whitney U test and t-test were used for group comparisons as appropriate. A *P*-value <0.05 was considered statistically significant. The area under the receiver operating characteristic curve (AUROC) was plotted to evaluate the predictive accuracy of RPR for severity, ICU stay, and in-hospital mortality.

Results

A total of 35 patients were included in the study. Among them, 21 (60%) were classified as having mild acute pancreatitis (MAP). Table 1 summarizes the baseline characteristics of the study population.

Table 1: Baseline characteristics of study population (n=35)

Variables	MAP (n=21)	SAP (n=14)	Overall (n=35)
Age (mean (SD))	50.76 (16.20)	57.35 (19.83)	53.4 (17.76)
Female (n, %)	13, 61.90%	11, 78%	24, 68.50
Platelets (median/IQR)	243 (201 - 332)	235 (161-335)	242 (178 - 331)
RDW-CV (median/IQR)	13.50 (13.07 – 14.40)	16.05 (15.30 - 18)	14.30 (13.10 - 16)
RDW-SD (mean (SD))	44.38 (3.75)	50.38 (5.83)	46.78 (5.49)
RPR (median/IQR)	0.0592 (0.0416 - 0.0686)	0.0652 (0.0472 - 0.1046)	0.0603 (0.0437 – 0.0758)
Lipase (median/IQR)	2280 (1335 - 11257)	2651 (995 - 4050)	2537 (1148 – 7312)
Cr (median/IQR)	0.7 (0.6 – 0.925)	1 (0.6 – 2.1)	0.8 (0.6 – 1.17)
SBP (mean (SD))	124 (12.87)	104 (18.27)	116 (18)
PaO2/FiO2 (median/IQR)	389 (332 - 409)	249 (232 - 371)	355 (300-407)
Required ICU, N (%)	0	71%	28%
Mortality, N (%)	0	28%	11%
Hospital stay, days (median/IQR)	5 (3-6.25)	9.5 (6-12)	6 (4-9.75)

RPR and its individual components were compared to determine their predictive values for disease severity and in-hospital mortality (Table 2, 3).

Table 2: RDW-CV, platelet count and RPR to predict severity of acute pancreatitis. (n=35)

Severity	Mild n=21	Severe n=14	*P*-value
RDW-CV median (IQR)	13.50 (13.07 – 14.4)	16.05 (15.30 - 18)	0.0014
Platelet count median (IQR)	243 (201 - 332)	235 (161-335)	0.6017
RPR median (IQR)	0.0592 (0.0416 - 0.0686)	0.0652 (0.0472 - 0.1046)	0.2813

Table 2 compares RDW-CV, platelet count, and RPR values between MAP and SAP groups. RDW-CV was significantly higher in SAP (median: 16.05, *P*=0.0014), while platelet count and RPR did not differ significantly between groups.

Table 3: RDW-CV, platelet count and RPR as predictors of in-hospital mortality (n=35)

Mortality	Yes n=4	No n=31	*P*-value
RDW-CV median (IQR)	17.90 (16.50-18.50)	14.10 (13.10-15.80)	0.0127
Platelet count median (IQR)	131 (99-233)	243 (206-360)	0.0335
RPR (mean (SD))	0.0129 (0.0520)	0.0573 (0.0206)	0.0158

Table 3 presents the comparison of hematological parameters between survivors and non-survivors. RDW-CV and platelet count differed significantly between the two groups (P=0.0127 and P=0.0335, respectively). RPR also trended higher in non-survivors, although the P-value was 0.0158.

The AUROC for RPR in predicting AP severity was 0.609, for ICU admission 0.664, and for in-hospital mortality 0.887 (Figures 1 and 2). An RPR cut-off of 0.1045 predicted mortality with 75% sensitivity and 100% specificity. For ICU admission, a cut-off >0.0675 showed 60% sensitivity and 76% specificity.

Figure 1: AUROC of RPR in predicting severity of Acute Pancreatitis (n=35)

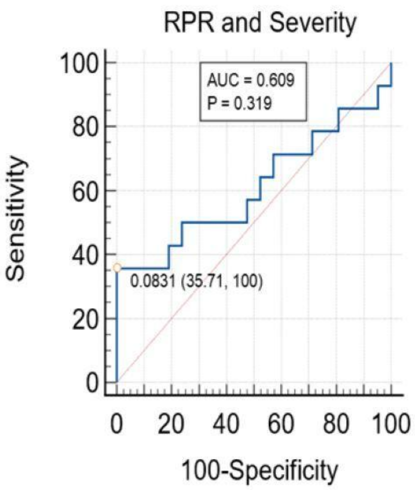
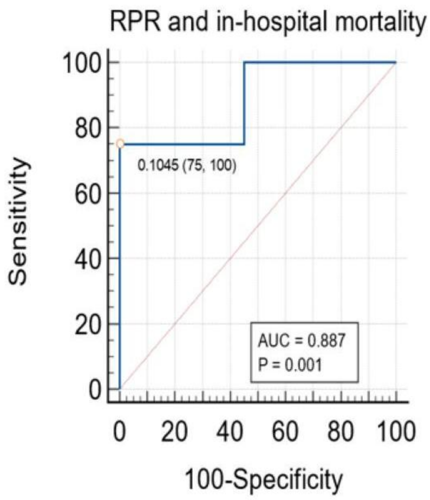


Figure 2: AUROC of RPR in predicting in-hospital mortality in Acute Pancreatitis (n=35)



Similarly, ROC analysis was performed to measure the accuracy of RDW-CV and platelet count on admission to predict the severity of AP. For SAP, the AUC of RDW-CV on admission was 0.821 with a cutoff of 14.7 (P<0.001). The AUC of platelet count on admission for SAP was 0.553 with a cutoff of 16100 (P=0.625). Thus, RDW-CV was useful in predicting both the severity and mortality of AP, whereas platelet count was only useful in predicting mortality.

Discussion

This study included 35 patients with acute biliary pancreatitis, ranging in age from 24 to 83 years. To minimize confounding variables, we excluded patients with alcoholic pancreatitis and known hematological or oncological disorders [9]. Of the total patients, 24 (68.5%) were female, likely reflecting the higher prevalence of gallstone disease among women [10]. Several studies support this finding, reporting an increased incidence of biliary pancreatitis in females [11,12]. In contrast to our observations, several studies have reported a higher prevalence of AP in men than in women [13,14]. Studies indicate that the age and sex distribution of AP varies based on its underlying causes, with different triggers influencing the demographics of affected individuals [15].

While AP is typically benign, severe cases carry high morbidity and mortality, requiring intensive care. In our study, 40% of patients were classified as having SAP, and the overall mortality rate was 11%, with all deaths occurring in the SAP group. These findings are consistent with earlier reports highlighting the significant morbidity and mortality associated with SAP [8]. Variation in mortality rates across institutions may reflect differences in ICU admission criteria, resource availability, and clinical protocols [4].

RDW has been increasingly recognized as a biomarker of systemic inflammation and disease severity. In our study, RDW-CV was significantly associated with both disease severity and in-hospital mortality, supporting existing evidence that elevated RDW correlates with worse clinical outcomes. RDW is influenced by multiple factors including alcohol consumption, iron and vitamin deficiencies, and sex, all of which may complicate its interpretation [8,16].

Platelet activation has also been implicated in AP pathogenesis. We found a statistically significant difference in platelet counts between survivors and non-survivors (median 243k vs. 131k; P=0.0335), indicating its potential role as a prognostic marker. However, platelet count alone did not significantly distinguish MAP from SAP [14,17].

Although RPR was elevated in SAP and in patients requiring ICU care or who died, its sensitivity for predicting disease severity was low (P=0.2813). This may be due to interindividual variability in platelet counts, as both thrombocytopenia and thrombocytosis were observed across severity groups, potentially blunting RPR's predictive power [18].

The AUROC for RPR in predicting in-hospital mortality was 0.887, indicating excellent discriminative ability. An RPR cut-off of 0.1045 detected 75% of mortality cases with 100% specificity. For ICU admission, RPR showed moderate predictive utility (AUROC=0.664). These findings align with previous research by Cetinkaya et al. [8], which demonstrated the prognostic value of RPR in AP.

Overall, while RPR is not a strong predictor of disease severity at presentation, it is a valuable marker for in-hospital mortality and ICU requirement. Its ease of calculation and availability from routine blood tests make it an attractive tool for clinical triage.

Limitations of this study include the small sample size and single-center design, which limit generalizability. Larger multicenter studies are recommended to further evaluate RPR's prognostic value and to establish standardized cut-off values.

Conclusion

RPR measured at hospital admission is a reliable predictor of in-hospital mortality and ICU requirement in patients with acute pancreatitis. Although it is less effective in identifying disease severity at presentation, RPR and RDW-CV are useful tools for early risk stratification and resource planning. Platelet count alone is less predictive of severity but may contribute to mortality prediction. Incorporating RPR into routine evaluation can assist in early identification of high-risk patients requiring close monitoring and possible early ICU transfer.

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J Surg Med. 2026;10(1):24-29.
https://doi.org/10.28982/josam.8243

JOSAM

Journal of Surgery and Medicine

e-ISSN: 2602-2079

Review
https://jsurgmed.com/

Nursing care plans for patients with ventricular assist devices: A holistic evaluation based on clinical observations and practice recommendations

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Abstract

Ventricular assist device (VAD) nursing is a critical specialty in the management of patients with advanced heart failure and cardiomyopathy. VAD nurses play an essential role in the preoperative preparation, intraoperative coordination, and postoperative care of patients receiving mechanical circulatory support, particularly those awaiting heart transplantation. These devices assist in improving cardiac function, but their use carries risks, such as infection, bleeding, thrombosis, device malfunction, and psychological challenges. Therefore, VAD nurses must possess expertise not only in general nursing care but also in infection prevention, anticoagulation management, patient education, and psychosocial support. As integral members of multidisciplinary teams, VAD nurses are responsible for educating patients on device management, ensuring safety, and promoting quality of life. With technological advancements, the role of VAD nurses has become increasingly significant in preventing complications and maintaining patient stability. In conclusion, VAD nursing is vital for improving patient outcomes and enhancing quality of life. Continued education and interprofessional collaboration are essential for advancing expertise and ensuring high-quality patient care.

Keywords: nursing care, advanced nursing practice, ventricular assist devices, artificial organs

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Ethics Committee Approval
Ethics committee approval is not required for this review article.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 January 16

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How to cite: Bektaş N. Nursing care plans for patients with ventricular assist devices: A holistic evaluation based on clinical observations and practice recommendations. J Surg Med. 2026;10(1):24-29.

Introduction

Ventricular assist device (VAD) nurses play a crucial role in the care of patients suffering from end-stage heart failure and cardiomyopathy (CMP), who are ineligible for immediate heart transplantation. These nurses are responsible for preoperative, intraoperative, and postoperative care, especially during the implantation of artificial hearts, the most critical stage in cardiovascular surgery [1,2].

According to the World Health Organization (WHO), heart failure is a clinical syndrome characterized by the heart's inability to pump blood effectively due to structural and functional impairments, leading to blood accumulation in the ventricles [2,3]. When the heart muscle fails to function adequately, conditions such as dilated CMP, hypertrophic CMP, and arrhythmogenic right ventricular CMP/dysplasia may be diagnosed. In cases where transplantation is not immediately possible, VADs are used as a life-saving intervention [3,4].

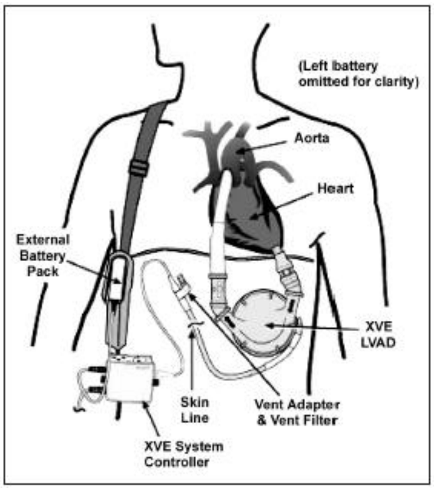
VAD usage involves risks both before and after surgery, including infection, bleeding, thrombus formation, and device malfunction [5]. It is essential to provide patient and caregiver education on wound care, medication administration, and technical aspects of the device [6].

Structure and Function of VAD Devices for Nurses

In severe cases of heart failure, patients are placed on transplant waiting lists with diagnoses such as dilated CMP, hypertrophic CMP, or arrhythmogenic right ventricular CMP. However, when immediate transplantation is not feasible, VADs offer a critical life-support option to prolong survival and improve quality of life [7].

Nurses must possess a clear understanding of the structure and functionality of VADs. As illustrated in Figure 1, the device is typically implanted in the upper left abdomen and connected to the left ventricle via an inflow cannula. The blood-contacting surfaces of the device create a pseudo-endothelial interface, helping to reduce immune rejection. The VAD facilitates forward blood flow through a graft anastomosed to the aorta. A driveline connects the internal pump to an external system controller, which powers and regulates the motor. This system also includes a channel for emergency manual operation in case of pump failure. The system controller receives power from batteries or direct electrical sources, allowing patients to monitor real-time cardiac data via a digital display.

Figure 1: Left ventricular assist device (LVAD) and placement. Reprinted with permission from Thoratec Corp., Pleasanton, CA.



Proper dressing of the driveline site is essential—initially requiring two to three dry dressing changes per day and, as healing progresses, once daily. Dressings must be secure to prevent cable irritation or damage [8].

The components of the implant, which are both functionally and symbolically significant, must be stored in secure, sterile containers post-implantation. The entire surgical team shares responsibility for the secure handling and storage of these parts. Following any procedure involving artificial heart components, the items must be placed in locked boxes and appropriately recorded. As shown in Table 1, nurses are responsible for safeguarding all components of the device [9].

To minimize error, all implants removed from sterile packaging must be supervised by the lead cardiac surgeon and device technician. The artificial heart nurse plays a vital role in ensuring sterilization protocols are followed. Before placing materials on the surgical table, all packaging must be double-checked, and serial numbers and expiration dates verified. Contaminated or questionable materials must be rejected and properly sterilized to maintain patient safety. Barcodes of all implanted parts must be documented and stored in the patient's medical file [10-12].

A spare pump kit should always be available, and artificial heart nurses must conduct monthly maintenance checks to ensure functionality and readiness [13].

Operating room and circulating nurses must conduct sponge, needle, and instrument counts at the start of the procedure, after explantation of the native heart, post-implantation of the VAD, and prior to sternum closure. In high-flow situations, additional counts are advised as needed [14]. Antibiotic prophylaxis initiated at device placement is another critical component of care [15]. Monitoring anticoagulation therapies such as heparin, aspirin, dextran, or warfarin is essential to prevent thromboembolic complications, especially during hypotensive episodes [16].

Following implantation, lactate dehydrogenase levels may increase, indicating heightened bleeding risk. In such cases, Ringer's lactate solution should be avoided unless prescribed. Administering fluids without proper evaluation can lead to serious nursing errors [16].

Intensive care unit nurses, operating room staff, caregivers, and technicians require competence in sterile dressing changes, device monitoring, documentation, and emergency procedures in case of device malfunction. Most alerts are related to battery status or connection issues. In the rare event of pump failure, patients or caregivers must be able to switch to manual pumping until professional help arrives [8–16].

Research Methods

This study employed a systematic review approach to synthesize existing literature in the field of VAD nursing. The research included peer-reviewed articles and relevant resources published between 2009 and 2025. The literature review was conducted using the CINAHL, Scopus, and Web of Science databases. Keywords used for the search included "VAD nursing," "vascular access," "nursing practices," and "vascular nursing." The selected studies were evaluated based on predefined inclusion and exclusion criteria. Inclusion criteria encompassed original research articles, reviews, and clinical guidelines related to VAD nursing. Studies were excluded if they were duplicates, pre-printed publications, or subject to language restrictions. As a result, 32 studies were deemed eligible for inclusion, and a detailed content analysis was conducted. Thematic analysis was applied to classify findings under relevant categories. This methodological approach aimed to provide a comprehensive perspective on VAD nursing practices and education, as well as to identify knowledge gaps in the field.

The Role of the VAD Nurse and the Care Plan

Patient refusal of treatment is not considered sufficient grounds for nurses to terminate the care process. In such cases, referral to a psychiatric evaluation is required. The compassionate approach of the nursing staff and the demeanor of the surgical team are essential during this period. The patient's relationship with psychiatric services must be supported. If decisions regarding the continuation or termination of care are to be made, multidisciplinary meetings between psychiatry and surgery teams—along with patient statements and the involvement of family members—play a significant role [19]. A more complex and demanding process begins after VAD implantation, and the quality of nursing care is critical to successful outcomes [5,18,19].

Waiting for transplantation or for a suitable donor heart is an emotionally taxing experience. Patients may become discouraged and refuse care after prolonged waiting periods. At such times, it is crucial to establish supportive communication addressing the patient's psychological state in order to maintain compliance with treatment.

Patient safety is the highest priority during all surgical interventions [19]. One of the nurse's essential responsibilities is to ensure effective communication within the healthcare team and to facilitate coordination when necessary.

Preoperative checklists help minimize mistakes and prevent erroneous events in regard to the patient, the site, the procedure, or the implant [20]. The informed consent specific to the artificial heart system must be signed by the patient [21]. According to hospital protocol, the surgeon must be present or confirmed to be on site before the patient is transferred to the operating room [22,23]. The patient is expected to demonstrate understanding of the procedure and express personal expectations [20–23]. Preoperative care orders issued by the surgeon—including administration of prophylactic intravenous antibiotics—must be followed precisely [20–23]. The nurse should work collaboratively with the anesthesia team and document the timing of prophylaxis [20–23].

On the morning of surgery, blood group and antibody verifications must be repeated. All blood products prepared for transfusion during surgery should be double-checked; if there is uncertainty, the anesthesia technician must be notified [20–23]. Hair from the chest and bilateral groin areas should be removed using battery-operated clippers, avoiding razors to prevent infection [21]. A preoperative shower and surgical site cleaning with chlorhexidine wipes are also required [23]. Patient transfer to the operating room must adhere strictly to established protocols [20–23].

At the beginning of the intraoperative period, all relevant units—including the nursing unit, anesthesia department, recovery room, and intensive care unit—must be notified and prepared for support [20]. Particularly during the transfer to intensive care, the patient should be moved promptly to a bed and allowed to rest without delay [23].

Plan of Nursing Care

VAD nurses must be fully cognizant of their legal responsibilities, duties, and scope of practice in the surgical setting [24]. Although there are currently no specific regulations exclusively for VAD nurses, their roles are generally governed by the standard regulations for operating room nurses in accordance with national nursing legislation [24].

The scrub (sterile) nurse works in the sterile field and is responsible for preparing all surgical instruments and materials, applying aseptic techniques, and ensuring proper infection control. This role involves maintaining patient safety through strict adherence to hand antisepsis and the correct donning of sterile gowns and gloves [24].

During surgery, the scrub nurse organizes instruments for accessibility and anticipates the surgeon's needs based on the procedure. In collaboration with the circulating (non-sterile) nurse, they conduct at least four counts of all surgical items—prior to surgery, during the procedure, and after closure—to ensure no materials are retained. The counted items are then handed over to the sterilization team [24].

The circulating nurse supports the surgical team by providing necessary materials before, during, and after the operation. Upon the patient's entry into the operating room, the nurse logs the procedure code and attempts to reduce patient anxiety. The circulating nurse is also responsible for controlling access to the operating room to ensure the safety of both the patient and the surgical team and remains present throughout the surgery. They ensure that sterile items are opened correctly and that the tissue specimens are handled, labeled, and sent to the laboratory appropriately [24].

A personalized nursing care plan should be developed for patients undergoing VAD implantation, particularly during the perioperative period. This plan should be based on established nursing diagnoses, interventions, and expected outcomes. As presented in Table 2, this process includes specific nursing activities tailored to the unique needs of VAD patients.

Education of Patients and Their Relatives

Educating patients with VAD implants is primarily the responsibility of nurses, who spend the most time with them [32]. A key aspect of this education is emphasizing the importance of proper device use and emergency preparedness [16,32]. One of the most common concerns patients express—often hesitantly—is, "What happens if the device suddenly shuts down or I go outside without realizing the battery is dead?" [29]. Through effective communication, patients are reassured that the device is designed to be safe even in emergencies. They are informed that the equipment can still be controlled even when the battery is depleted and that they should go to the hospital immediately if such a situation arises [27]. Patients are advised to stay calm to help their body adapt to the change in heart rhythm during such events [10,27,32].

A comprehensive written guide is given to the patient. It covers such topics as the system controller, alarms, external power sources, batteries, travel equipment, and maintenance tools. This

Table 1: Basic implant parts of the artificial heart

Basic Implant Parts of the Artificial Heart	
During implantation:	**Post-implantation:**

○ **Heart pump (HeartWare Pump)**
○ **Outflow graft**
  ○ Closed graft implant kit (sealed implant kit)
  ○ Pocket controller
  ○ Implant accessory kit
  ○ Closed inlet pipe (Sealed inflow conduit)
  ○ Sealed grafts with anti-kink closed exit Outflow grafts with bend relief
  ○ Sealed outlet pipe (sealed outflow bend relief collar)
  ○ Apical suture ring (Apical sewing ring)
	○ Battery
	○ Charger (battery charger)
	○ Heart pump control kit (HeartWare control kit)
	○ Transfer cable within the system (driveline extension cable)
	○ Surgical tool kit

Table 2: Artificial heart support provided by nurses

Nursing Interventions for Patients with Artificial Heart Support		
Nursing Diagnosis	**Nursing Initiative**	**Evaluation Conclusion**
During the first three postoperative days, all critical nursing diagnoses, such as risk of bleeding, risk of infection, risk of fluid and electrolyte imbalance, and risk of impaired airway patency are thoroughly assessed, and corresponding interventions are implemented with the highest priority.		
Risk of Bleeding	Observe early signs of bleeding, such as petechiae, ecchymosis, nosebleeds, hematuria. Maintain drainage tubes below heart level. Monitor blood pressure, tachycardia, central venous pressure, anemia, PT, PTT, platelet count, ACT; vital signs hourly or thrice daily if not ordered by physician. Monitor hourly drainage. Administer platelet, erythrocyte suspension, fresh frozen plasma as needed. Adjust heparin infusion with physician. Inspect incision and device exit sites for bleeding.	Normal drainage without excessive bleeding. Blood gas and laboratory values within normal ranges. No visible bleeding observed.
Risk of Infection **Risk of Skin Integrity** **Disruption**	Care is planned to be minimally invasive to reduce procedure duration, limiting interventions to essential areas only. Prior to providing care, thorough hand washing is performed, gloves are worn, and appropriate protective clothing is used, especially when full isolation is required. Isolation protocols are strictly followed for surgical wound infections. The patient's susceptibility to infection is continuously assessed. Culture samples are collected upon physician request. The surgical incision site is classified and monitored regularly. Sterile techniques are employed when necessary to prevent contamination. Measures are taken to protect the patient from cross-contamination. Prophylactic treatments are administered according to the physician's orders. The patient is closely monitored for signs and symptoms of infection; any occurrence of high fever prompts immediate communication with the surgical team. Continuous observation of the patient's condition is maintained. The patient is positioned correctly and repositioned every two hours to prevent complications. Signs and symptoms of physical injury to the skin and underlying tissues are evaluated, including assessment of tissue perfusion. Daily dry sterile dressings are applied to all surgical wounds, and the wound healing process is regularly assessed. Postoperative factors increasing infection risk are evaluated following the procedure. Perioperative monitoring includes evaluation for infection signs and symptoms for up to 30 days after surgery.	The patient exhibits no signs or symptoms of infection at the incision site upon hospital discharge, including absence of pain, redness, swelling, drainage, or delayed wound healing. ▪ The surgical wound is covered with a dry sterile dressing upon transfer from the operating room. ▪ The patient remains afebrile and shows no clinical evidence of infection. ▪ Preoperative and postoperative antibiotic therapies administered according to established guidelines, with no subsequent signs or symptoms of infection observed. ▪ Any hyperemia observed resolved within 30 minutes. ▪ The patient reports no pain or numbness related to surgical positioning and shows no signs or symptoms of positioning-related injury. ▪ Skin assessment reveals smooth, intact skin free from cuts, abrasions, lacerations, rashes, or blisters. ▪ Neuromuscular evaluation confirms that the patient can flex and extend extremities independently and denies any numbness or tingling sensations.
Risk of Fluid – Electrolyte Imbalance	Identify factors associated with an increased risk of bleeding or fluid and electrolyte imbalance. (If lactate dehydrogenase levels are elevated, Ringer's lactate is avoided unless specifically requested by the physician for fluid replacement.) Report any deviations in diagnostic test results and repeat urine-specific gravity measurements every two hours. Monitor central venous pressure hourly. Evaluate and document the amount and characteristics of fluid draining from chest tubes. Apply appropriate hemostatic techniques as needed. Maintain hourly records of the patient's fluid intake and output, document occurrences of vomiting, diarrhea, fever, and additional fluid losses from tubes and drains. Continuously monitor physiological parameters. Review arterial blood gas results regularly. Administer electrolyte replacement therapy as prescribed. Assess the patient's response to fluid and electrolyte administration.	The patient's vital signs remain within the expected range for discharge from the operating room. The patient maintains hemodynamic stability during positional changes while being transferred to the postoperative intensive care unit. Urine output is closely monitored and maintained within normal limits. The patient's fluid, electrolytes, and acid-base balances are preserved at baseline levels or show improvement.
Risk of Inadequate Airway Patency **Aspiration Risk**	Due to the presence of an endotracheal tube, suctioning is performed every two hours based on the patient's condition. In cases of obstruction, suctioning is conducted using 2–3 cc of sterile saline. This procedure should be brief, with continuous monitoring of oxygen saturation via pulse oximetry. Respiratory rate is recorded four times per hour. Any abnormalities in arterial blood gas results are promptly reported. Physiological parameters are continuously monitored. If tidal volume decreases, the physician is notified immediately. The patient is encouraged to perform deep breathing and coughing exercises, in collaboration with the respiratory therapist. The patient's respiratory status is maintained at baseline or shows improvement.	The patient's arterial oxygen saturation (SaO2) remains within the expected range; the rate, depth, and symmetry of respirations are stable or improved compared to preoperative assessments. Cognitive status: The patient responds appropriately to questions, and memory function is intact. Vital signs: Blood pressure, temperature, oxygen saturation measured by pulse oximetry (SpO2), and pulse rate are all within expected ranges.
Risk of Injury	Prior to the initiation of surgery, the patient's identity is confirmed, and the surgical site is clearly marked in advance. The correct patient and surgical site are verbally confirmed by the entire surgical team. The planned VAD procedure is announced aloud in the operating room. Scrub and circulating nurses perform and document counts of all surgical materials before the intervention; if discrepancies arise, corrective measures must be taken immediately after the procedure. Patient privacy is rigorously maintained throughout the process. Patient information is disclosed only to healthcare personnel directly involved in the patient's care. Nurses serve as patient advocates by protecting them from inadequate, unethical, or unlawful practices. The patient's initial skin condition is thoroughly assessed prior to surgery.	The surgical team confirms that the intervention was performed at the correct anatomical site, side, and level. The patient receives competent and ethical care in accordance with established legal and professional standards.
Risk of Body Temperature Imbalance	▪ The risk of normothermia dysregulation is assessed. Both hypothermia and hyperthermia are closely monitored. ▪ Any deviations in diagnostic test results are reported immediately. ▪ Thermoregulation interventions are implemented, and the patient's response is evaluated continuously. ▪ Body temperature is frequently monitored, specifically every 15 minutes during the first 24 hours postoperatively. ▪ Physiological parameters are continuously observed.	▪ The patient's body temperature is maintained above 36°C (96.8°F) upon discharge from the operating room. ▪ The patient is in the immediate postoperative phase and has returned to, or is returning to, normothermia by the end of the monitoring period.
Cardiac Insufficiency Output	The patient's initial cardiac status is thoroughly documented. Vascular conditions and any previous surgical or invasive procedures are reviewed through detailed patient interviews. Supporting data is gathered from available technological devices to facilitate a comprehensive evaluation. Renal function is carefully assessed to ensure homeostasis is maintained. The presence of any implantable cardiac devices is identified and duly reported. Any abnormalities or deviations observed in diagnostic test results are promptly communicated.	Cardiovascular status: The patient's heart rate and blood pressure are within expected limits; peripheral pulses are present and symmetrical bilaterally; the skin is warm to the touch; no cyanosis or pallor is observed; capillary refill time is less than three seconds. Respiratory status: The patient's arterial oxygen saturation (SaO2) is within normal range. Skin condition (general): The conjunctiva and mucous membranes appear pink, with no signs of cyanosis or pallor. Renal status: Urine output exceeds 30 mL/hour, with specific gravity ranging between 1.010 and 1.030.
Fear **Anxiety** **Lack of Information** **Inadequacy in Communication** **Ineffective Family Management of the Therapeutic Regimen**	Assesses the patient's psychosocial status and collaborates with the healthcare team to evaluate neurological function. Evaluates the patient's coping mechanisms and implements interventions to provide psychological support. Screens for signs and symptoms of anxiety and fear. Creates a calm and supportive environment to address home care needs and alleviate anxiety when present. Identifies sensory impairments and potential communication barriers. Determines the educational needs of both the patient and their family. Explains the expected sequence of events related to the surgical and recovery process. Monitors the patient's response to interventions and develops a personalized care plan accordingly. Explores the patient's perceptions and concerns regarding surgery. Verifies patient allergies to prevent adverse reactions. Documents the psychosocial status comprehensively. Assesses patient-specific challenges related to medication management. Provides perioperative education to the patient and/or their caregiver. Evaluates the effectiveness of educational interventions. Supplies information regarding prescribed medications.	▪ Patients and their relatives are informed about the potential feelings of anxiety, fear, and worry that may arise before and immediately after surgery. ▪ Psychological support is provided to both patients and their family members. ▪ Patients are guided to verbalize realistic expectations regarding the effects of medications on postoperative recovery prior to hospital discharge. ▪ They are educated about the possible side effects of medications prescribed at discharge. ▪ Patients and/or their relatives are able to accurately identify the correct dosage, frequency, and purpose of each medication.

document is intended to reduce anxiety and promote self-confidence in managing the device.

The dressings around the driveline—the tubes connecting the internal and external components—should be changed daily using a sterile, dry technique [32]. Although surgical site infections can be treated under hospital conditions with full sterility, failure to perform proper dressing changes at home may lead to serious infections that affect the device's output line [28]. Therefore, patients must be taught how to apply dressings in a simple, clear, and hands-on manner [26].

Patients can generally continue their activities of daily living (ADLs), but they are advised to avoid strenuous or emotionally intense activities [27]. The ability to resume ADLs is determined by the surgeon and based on specific postoperative criteria [29–32]. If the cardiac output displayed on the device monitor falls below 3.5 liters, patients are instructed to contact the clinical team immediately [30–32]. It is recommended that patients check the device's battery status every two hours using alarms or reminders [31,32]. Additionally, once a suitable donor heart becomes available, patients are informed that they must arrive at the hospital within two hours [32].

Conclusion

In addition to providing direct patient care, VAD nurses support the surgical team throughout the entire treatment process—from the patient's hospital admission for artificial heart implantation to the heart transplantation itself. Successful implantation requires detailed planning, interdisciplinary collaboration, coordinated efforts, and clinical competence.

In the preoperative phase, the VAD nurse ensures open communication with the patient, answers questions to reduce anxiety, and thoroughly prepares the patient for surgery—steps essential to the success of the procedure. During surgery, the VAD nurse actively participates in teamwork, identifies potential complications in advance, and implements contingency plans to deliver high-quality, safe care.

With the continuous evolution of VAD technologies, ongoing annual training for VAD nurses and relevant hospital staff is a necessity. Beyond the responsibilities of operating room nursing, VAD nurses must also focus on improving the quality of life for patients through empathy, patient education, communication, and crisis management. Managing a device that supports a vital organ like the heart demands the dedication and expertise of highly trained nurses. VAD nursing is thus a cornerstone in the treatment of advanced heart failure.

Suggestions

Based on the findings of this study, several recommendations can be made to enhance the quality of VAD nursing. VAD nurses should be encouraged to participate regularly in case conferences and interdisciplinary training programs, as such collaboration strengthens both patient care and teamwork among healthcare professionals. Continuing education must be supported through simulation-based training, and evidence-based clinical guidelines to ensure up-to-date knowledge and skill development. Additionally, it is essential to adopt and routinely update national and international care protocols, which help maintain consistent and effective practices during the perioperative period. Providing nurses with training in emergency scenarios is also crucial, as it improves their ability to respond competently to complications that may arise during surgical procedures. Furthermore, educational materials tailored to patients and their families should be developed to facilitate their adaptation to life with a ventricular assist device. Finally, considering the high workload and emotional stress associated with this role, supportive working environments should be fostered, and institutional policies should be implemented to promote the well-being and job satisfaction of VAD nurses.

Acknowledgements

I would like to express my sincere gratitude to all my professors who encouraged and supported me in preparing this study for publication.

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JOSAM
Case report
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

Os trigonum syndrome with clinical and radiological findings

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Informed Consent
The authors stated that the written consent was obtained from the patient presented with images in the study.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 January 19

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Abstract

Os trigonum is a rare accessory bone located posterior to the os talus. This bone develops as a secondary ossification center in the posterior of the talus between the ages of 7-13 years and fuses with the talus via synchondrosis within the following year. If this union does not occur, an accessory bone called the os trigonum is formed, which is usually asymptomatic. Os trigonum syndrome (OTS) refers to a clinical condition characterized by posterior foot pain during forced plantar flexion of the ankle due to compression between the posterior malleolus of the tibia and the tuber calcaneus. Diagnosis is based on the patient's clinical history, examination, and radiological findings. We present the case of an 18-year-old male with a history of an ankle sprain sustained during strenuous sports activity. Clinical evaluation revealed pain, swelling, and ecchymosis on the posterior foot. Magnetic resonance imaging (MRI) demonstrated an accessory os trigonum with medullary edema in the posterior talus, fluid accumulation, and flexor hallucis longus tenosynovitis. Conservative treatment involving a three-week break from sports and medical management was prescribed. This case highlights the importance of considering OTS in the differential diagnosis of posterior foot pain aggravated by plantar flexion.

Keywords: os trigonum syndrome, os trigonum, magnetic resonance

Introduction

The os trigonum is a triangular or oval-shaped accessory bone located posterior to the talus, first described as an anatomical variant by Rosenmüller in 1824 [1-3]. It is present in approximately 7-25% of the population. This bone develops as a secondary ossification center in the posterior talus between the ages of 7-13 years. If this center fails to fuse with the talus, it remains as an independent accessory bone known as the os trigonum [1, 2].

Os trigonum syndrome (OTS) refers to posterior foot pain resulting from compression of the os trigonum between the posterior malleolus of the tibia and the tuber calcaneus during forced plantar flexion—a phenomenon described as the "nutcracker mechanism" [3-5]. Also known as talar compression or posterior ankle impingement syndrome, OTS can be triggered by repetitive microtrauma or acute injury, particularly in sports-related activities [2, 4].

This report presents a case of OTS diagnosed following an ankle sprain, emphasizing clinical and radiological findings, which underline the diagnostic challenges and therapeutic considerations.

How to cite: Doğan D, Baş N. Os trigonum syndrome with clinical and radiological findings. J Surg Med. 2026;10(1):30-32.

Case presentation

An 18-year-old male presented to the orthopedic outpatient clinic with complaints of right ankle pain and swelling after a sports-related injury. Clinical examination revealed pain, edema, and ecchymosis localized to the posterior foot. Radiological imaging was conducted using a GE Signa Explorer 1.5 Tesla MRI, obtaining multiplanar T1, T2, and fat-suppressed sequences (Figure 1-4).

MRI findings revealed:

- An accessory bone consistent with the os trigonum.
- Medullary edema in the posterior talus.
- Increased fluid in the surrounding area.
- Signal changes indicative of flexor hallucis longus tenosynovitis.
- Edema and hyperintensity in the posterior subcutaneous tissue.

These findings confirmed the diagnosis of OTS. Conservative treatment, including a three-week break from sports and the administration of anti-inflammatory medication, was prescribed.

Figure 1. Sagittal T1-Weighted MR examination; accessory bone tissue compatible with the os trigonum in the posterior of the talus.

Figure 2. In T2-Weighted MR examination with sagittal fat suppression; increased fluid around the os trigonum.

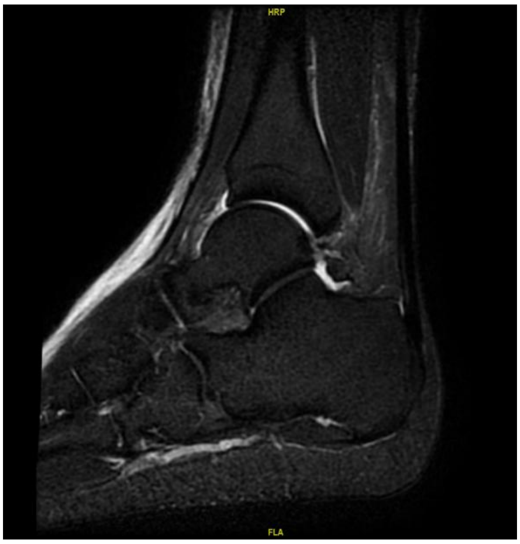


Figure 3. In T2-Weighted MR examination with sagittal fat suppression; increased edematous signal in the talus and calcaneus posterolateral

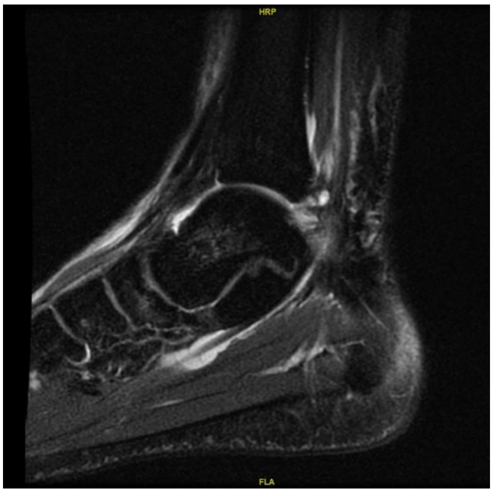
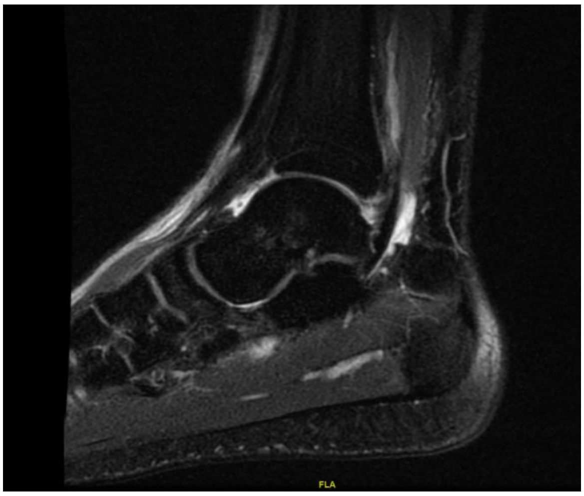


Figure 4. In the fat-suppressed T2-A MR examination; Increased signal in the flexor hallucis longus tendon consistent with tenosynovitis



Discussion

Os trigonum syndrome commonly presents as posterior ankle pain due to repetitive plantar flexion during high-impact activities. Diagnosis is typically based on patient history, clinical examination, and imaging findings [1, 4].

In this case, clinical examination revealed tenderness over the posterior talus and increased pain with forced plantar flexion. Radiological findings, including the presence of an os trigonum and associated inflammation, supported the diagnosis.

Primary treatment for OTS is typically conservative, involving rest, nonsteroidal anti-inflammatory drugs, and physical therapy [1, 6]. Advanced interventions, such as ultrasound or fluoroscopy-guided injections, are considered for refractory cases. Surgical excision may be indicated for athletes who experience persistent symptoms despite conservative management, with favorable outcomes reported in ballet dancers and football players [7, 8].

Recent studies highlight the role of endoscopic techniques for os trigonum excision, offering reduced complication rates and faster recovery compared to open surgery. MRI plays a crucial role in preoperative planning by identifying tendon pathologies, osteochondral lesions, and associated soft tissue inflammation [9, 10].

Conclusion

In conclusion, OTS should be considered in the differential diagnosis of posterior foot pain, particularly in individuals engaged in activities requiring forced plantar flexion.

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JOSAM
Journal of Surgery and Medicine
e-ISSN: 2602-2079

Hybrid repair of early aortobifemoral graft occlusion in a patient with antiphospholipid syndrome: A case report

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Informed Consent
The authors stated that the written consent was obtained from the patient presented with images in the study.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 January 30

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Abstract

Complete thrombosis of an aortic segment and unilateral graft limb after aortobifemoral bypass is a rare but severe complication. We report the case of a 41-year-old female patient who presented 2.5 months after aortobifemoral bypass for Leriche syndrome with recurrent claudication and ischemic rest pain. Imaging revealed complete thrombosis of the proximal aortic segment and the right iliac graft limb. A hybrid repair was performed consisting of bilateral groin incisions, thrombectomy, endarterectomy, and placement of kissing covered stents. Postoperative recovery was uneventful, with restored perfusion and good graft patency on follow-up. Thrombophilia screening demonstrated antiphospholipid syndrome, which was considered an important contributor to the early graft failure. This case illustrates that hybrid repair can be a safe and effective option for early aortobifemoral graft occlusion and highlights the importance of systemic evaluation for prothrombotic disorders in young patients presenting with unexplained thrombosis.

Keywords: aortobifemoral bypass, graft thrombosis, hybrid procedure, antiphospholipid syndrome

Introduction

Aortobifemoral bypass graft (AoFG) surgery is commonly used for the treatment of Leriche syndrome [1]. The TransAtlantic Inter-Society Consensus, based on the morphological classification of lesions, helps to determine whether an endovascular or open procedure is advised [2]. Graft limb thrombosis after AoFG is relatively rare.

When graft occlusion occurs, thrombectomy of the graft limb is indicated. When thrombectomy is not successful, an abdominal graft replacement must be weighed versus the current patency rates of the extra anatomic grafting [3-5]. When performing an open AoFG replacement, significant blood loss, iatrogenic trauma, and a technically difficult procedure can be expected.

How to cite: Vermylen L, Daenen G, Stabel P, Avet J, Peeters K. Hybrid repair of early aortobifemoral graft occlusion in a patient with antiphospholipid syndrome: A case report. J Surg Med. 2026;10(1):33-36.

Case presentation

A 41-year-old female patient presented to the emergency department with recurrence of intermittent claudication pain for several weeks, acute onset of a colder foot on the right side, and nightly ischemic rest pain. The patient had previously undergone percutaneous transluminal angioplasty (PTA) with stenting of the common iliac artery (CIA), external iliac artery (EIA), and distal EIA on the right side. Sixteen months later, she presented with a Leriche syndrome type D, following TransAtlantic classification (TASC) II, for which an aortobifemoral silver dacron graft was placed and bilateral groin incisions for anastomosis on the common femoral artery (CFA) were made. Cardiovascular risk factors included smoking (20 pack years) with complete cessation after her first operation, hypercholesterolemia, and a strong family history of arterial disease at a young age. Post-operatively, an anti-platelet aggregation inhibitor and anti-hypercholesterolemia drugs were started. The latter was stopped on the patient's own behalf due to general discomfort.

Computed tomography (CT) peripheral angiogram revealed a total occlusion of the AoFG stenting at 1.5 centimeters (cm) of the proximal anastomosis (Figure 1). On the right-side, the entire length of the CFA was occluded (Figure 2). On the left side, we can see an occlusion of the limb of the graft with an open native circulation (Figure 2). The patient was scheduled for a hybrid operation with bilateral thrombectomy through an open bilateral groin incision and endarterectomy at the femoral bifurcation on the right side. Fogarty® graft thrombectomy catheters were introduced, opened, and retracted multiple times. Angiography showed a floating thrombus in the main body, which could not be recuperated, even by simultaneous thrombectomy of both limbs. The decision was made to employ kissing Covera covered stents (8x40 right and 8x80 left). Profundaplasty at the right CFA and the proximal superficial femoral artery (SFA) was performed. The left arteriotomy was primarily closed. Perioperatively, two units of O negative red blood cells were administered. Post-operatively, posterior tibial arteria pulsation was palpated bilaterally and dual antiplatelet therapy was started. The post-operative hospitalization duration was three days and uncomplicated. Control after six weeks showed no residual claudication complaints and good patency of the AoFG. Thrombophilia screening was performed at the follow-up consultation and was positive for antiphospholipid syndrome (APS). Biochemical testing was positive for all three antiphospholipid (anticardiolipin antibodies, lupus anticoagulant and anti-β2 glycoprotein 1 antibodies).

Figure 1: CTA 3 months post-AoFG showing inflow in the native aorta and AoFG, occlusion of both graft limbs, and complete occlusion of the right CFA with preserved native left-sided perfusion.

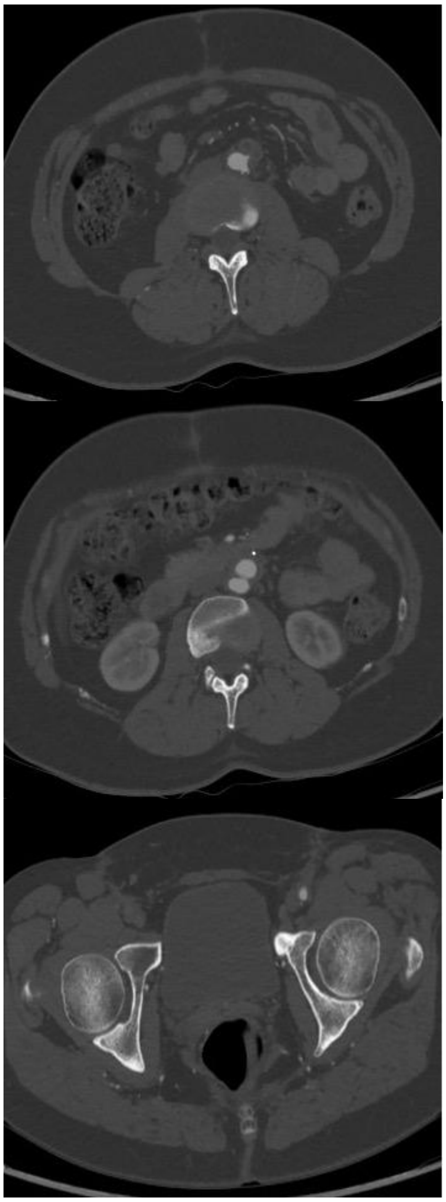

Figure 2: CTA 3 months post-AoFG showing occlusion of the right CIA, EIA and CFA; the AoFG is occluded 1.5 cm distal to the proximal anastomosis with retrograde filling of the left limb.

Discussion

In the treatment of Leriche syndrome an open aortofemoral bypass graft (AoFG) surgical procedure is commonly executed [1,5]. Other surgical treatment options are thromboendarterectomy (TEA) or percutaneous transluminal angioplasty (PTA) with or without stenting. The long-term patency rates observed with AoFG are 85-90% after five years and 75-80% after ten years [5,6]. The TransAtlantic Inter-Society Consensus lesions help to determine whether an open or endovascular procedure is indicated [7]. Types A and B are preferably managed endovascularly. Types C (low risk patients) and D lesions are managed by bypass graft. In the present case, AoFG surgery was performed due to type D lesions. In some instances, a type C or D lesion can be treated endovascularly.

Graft limb thrombosis after AoFG has an incidence of 14.5-30%. Higher rates are seen among females, younger patients, and those who continue to smoke and with extra-anatomical bypasses [3].

Leriche syndrome, especially when accompanied with continued smoking, is associated with a difference in patency [8].

The median time between AoFG and presentation with thrombotic episode is 2.6 years [3]. Most studies define early occlusion as occurring in the first 30 days post-operatively. Early occlusion is primarily due to a technical defect or inadequate flushing of the fresh thrombus from the graft before flow restoration [3,6]. When late occlusion (after 30 days) occurs, the most common reason for thrombosis is outflow stenosis due to vascular disease or secondarily, due to neointima hyperplasia [9]. In case of an occlusion, graft thrombectomy by groin cutdown has a success rate of 82-97% [3,6,10,11]. Whenever the graft limb thrombectomy is not successful or when bilateral occlusion occurs, an abdominal graft replacement has to be weighed versus the expected patency rates of the extra anatomical grafting. High morbidity and mortality is reported when performing an extra anatomical grafting [3,4,6,12]. Catheter-directed thrombolysis does not prevent an open operation in most cases and is expensive when both are needed [12].

When performing thrombectomy, large amounts of residual thrombus have been seen. Usage of a thrombectomy instrument may, in theory, disrupt the prosthetic graft wall. Caution and gentle handling are required when performing the scraping maneuver [6]. Once the thrombectomy has been performed, the outflow stenosis has to be treated; typically, the SFA and sometimes in severe stenosis the CFA are occluded. As shown by Fisch et al., a combined retrograde thrombectomy with treatment of native runoff artery anomalies can restore long-term patency after thrombosis with low mortality and morbidity [11].

Due to the fact that the open AoFG placement was only 2.5 months prior, a redo AoFG or placement of an extra anatomical bypass would be associated with high morbidity rates, significant blood loss, possible iatrogenic trauma, and a technically difficult procedure. Therefore, we planned a hybrid operation with an open femoral artery reconstruction and thrombectomy. In this case thrombectomy alone was not fully successful, with residual floating thrombus in the main body on angiography. We decided to perform an endovascular kissing stent graft placement.

Use of a kissing stent has been shown to be associated with higher risks of restenosis and reocclusion at the aortoiliac bifurcation, due to a bad apposition between the kissing stent and the arterial wall/graft, responsible for incorrect re-reendothelialization, neointimal hyperplasia, and eventually early thrombosis [13,14]. Studies have reported a five-year primary rate and assisted primary patency rate of 63-92% and 81-100% [15].

In this case the endovascular kissing stent graft technique was preferred over an open redo AoFG or placement of extra anatomical bypass because of the recent primary laparotomy and the high risk of open redo surgery. Due to the reconstruction of the distal arterial outflow with the help of a profundaplasty, a higher patency rate can be expected by solving the problem of late occlusion after 30 days.

The hematology department at our institute informed us that, due to the elevated levels of all three antiphospholipid antibodies, a positive result after 12 weeks can be expected. In cases of antiphospholipid syndrome, biochemical testing should be repeated after 12 weeks. Co-occurrence Leriche syndrome and APS, as suspected in the present case, is rare, may present with varying atypical symptoms, and can be very dangerous. Early revascularization is the recommended therapy when Leriche syndrome and APS co-occur post-operatively; secondarily, thromboprophylaxis is recommended [16]. Screening for prothrombotic conditions such as antiphospholipid syndrome should be considered in young patients with unexplained thrombosis.

Conclusion

A hybrid operation, thrombectomy, kissing stent graft combined with open groin incisions, and profundaplasty, can provide good short-term results in patients with aortoiliac unilateral limb occlusion after aortobifemoral graft placement. Studies to determine the short- and long-term effects and indications of the kissing stent technique in aortobifemoral grafting should be conducted in the future. Screening for prothrombotic conditions such as antiphospholipid syndrome should be considered in young patients with unexplained thrombosis.

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