

Donor Site Morbidity After Radial Forearm Free Flap Harvest: Current Concepts and Clinical Perspectives

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ABSTRACT

Background: The radial forearm free flap (RFFF) is one of the most reliable and versatile microvascular flaps used for reconstruction of head and neck defects following oncologic resection, trauma, and congenital deformities. Owing to its thin, pliable skin paddle, long vascular pedicle, consistent vascular anatomy, and ease of harvest, it remains the preferred choice for soft-tissue reconstruction. Despite its excellent reconstructive outcomes and high flap survival rates, donor-site morbidity continues to be a significant concern because it may adversely affect functional recovery, cosmetic appearance, and overall patient satisfaction. Numerous modifications in flap harvesting and donor-site closure, including suprafascial dissection, full-thickness skin grafts, local advancement flaps, and negative-pressure wound therapy, have been introduced to reduce these complications. Careful patient selection, meticulous surgical technique, individualized donor-site reconstruction, and structured postoperative rehabilitation remain essential for minimizing donor-site morbidity while preserving the reconstructive advantages of the RFFF. This narrative review summarizes the current evidence on donor-site morbidity following radial forearm free flap harvest, discusses the spectrum of associated complications, and highlights contemporary strategies for their prevention and management.

Keywords: Radial forearm free flap; donor-site morbidity; head and neck reconstruction; wound healing; skin graft; microvascular reconstruction.

INTRODUCTION

Reconstruction of head and neck defects following oncologic resection, trauma, or congenital deformities remains one of the most challenging aspects of oral and maxillofacial surgery. The primary objective of reconstruction is not only to restore anatomical continuity but also to achieve optimal functional outcomes, including speech, mastication, swallowing, and facial aesthetics. Advances in microvascular surgery have revolutionized reconstructive procedures by enabling the transfer of well-vascularized tissues that closely resemble the lost structures in both form and function.^{1,2}

Since its introduction by Yang et al. in 1981, the radial forearm free flap (RFFF) has become one of

the most extensively utilized fasciocutaneous free flaps for reconstruction of soft-tissue defects of the head and neck. Its popularity stems from several inherent advantages, including a long and reliable vascular pedicle, consistent vascular anatomy, thin and pliable skin paddle, ease of flap elevation, and versatility in reconstructing defects of varying sizes and configurations. These characteristics make the RFFF particularly suitable for reconstruction of the tongue, floor of the mouth, buccal mucosa, pharynx, and other intraoral soft-tissue defects where restoration of mobility and function is essential.⁴

Despite its excellent reconstructive reliability and consistently high flap survival rates, donor-site morbidity remains the principal drawback

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associated with the RFFF. Harvesting of the flap often results in a donor defect that cannot be closed primarily, particularly when larger skin paddles are required.^{2,3}

Over the past two decades, numerous modifications in flap design, harvesting techniques, and donor-site closure methods have been proposed to minimize morbidity while preserving flap reliability. These include suprafascial flap elevation, full-thickness skin grafts, local advancement flaps, acellular dermal matrices, negative-pressure wound therapy, and tissue-engineered substitutes.⁴ Although several studies have demonstrated favourable outcomes with these techniques, there remains no universally accepted approach for donor-site management, and considerable variation exists among reconstructive centres.¹

The aim of this narrative review is to critically evaluate the current evidence regarding donor-site morbidity following radial forearm free flap harvest, summarize the incidence and spectrum of associated complications, compare contemporary donor-site management techniques, and discuss practical strategies for minimizing morbidity while maintaining the reconstructive advantages of this versatile free flap.

Anatomy and Surgical Technique of Radial Forearm Free Flap Harvest

The radial forearm free flap (RFFF) is a fasciocutaneous flap based on the radial artery and its accompanying venae comitantes. Since its introduction, it has become one of the most reliable free flaps for reconstruction of head and neck soft-tissue defects because of its consistent vascular anatomy, long vascular pedicle, thin and pliable skin paddle, and technical ease of harvest. The flap provides excellent tissue characteristics for reconstructing intraoral defects while maintaining high flap survival rates.^{5,6}

The radial artery originates from the brachial artery at the level of the cubital fossa and courses distally along the lateral aspect of the forearm between the brachioradialis and flexor carpi radialis muscles before entering the anatomical snuffbox.⁴ Numerous septocutaneous perforators arising from the radial artery supply the overlying skin and fascia, providing a dependable vascular network for

flap harvest. Venous drainage is achieved through the venae comitantes accompanying the radial artery and, when required, the cephalic vein can also be included to facilitate venous outflow.⁵

Preoperative assessment of hand vascularity is essential before flap harvest. An Allen's test should be routinely performed to confirm adequate collateral circulation through the ulnar artery and the superficial and deep palmar arches. In selected cases, Doppler ultrasonography or angiography may be employed to further evaluate vascular anatomy, particularly in patients with previous trauma, vascular disease, or equivocal Allen's test findings.^{1,2}

The flap is generally harvested from the non-dominant forearm to minimize postoperative functional impairment. The dimensions of the skin paddle are designed according to the recipient defect and may extend from the wrist flexion crease proximally towards the antecubital fossa. Skin thickness varies among individuals and is typically thinner in female patients, making the flap particularly suitable for reconstruction of delicate intraoral structures such as the tongue, floor of the mouth, buccal mucosa, and pharynx.⁶

Following skin marking, the incision is made along the predetermined flap outline. The skin, subcutaneous tissue, and deep fascia are elevated while carefully preserving the vascular pedicle. The radial artery and its venae comitantes are meticulously dissected, with particular attention paid to preserving adjacent tendons, muscles, and superficial sensory nerves. Depending on reconstructive requirements, the cephalic vein may also be harvested to provide an additional venous anastomosis. Once flap elevation is complete, the vascular pedicle is divided and transferred to the recipient site for microvascular anastomosis.^{10,11}

Closure of the donor site depends primarily on the size of the harvested flap. Small defects may be closed primarily; however, larger defects usually require reconstruction with a split-thickness skin graft (STSG). Alternative techniques, including full-thickness skin grafts (FTSG), local advancement flaps, V-Y closure, acellular dermal matrices, and negative-pressure wound therapy (NPWT), have been described to improve wound healing, reduce tendon exposure, and enhance cosmetic outcomes.⁷

Recent modifications in harvesting techniques, particularly suprafascial flap elevation, have gained popularity because they preserve the paratenon covering the flexor tendons, thereby reducing the incidence of tendon exposure, improving skin graft survival, and minimizing donor-site morbidity without compromising flap vascularity. Consequently, many reconstructive surgeons now advocate suprafascial dissection whenever technically feasible.⁵

Different Techniques of Radial Forearm Free Flap Harvest

1. Conventional Fasciocutaneous Radial Forearm Free Flap

The conventional fasciocutaneous radial forearm free flap is the most widely used variant for reconstruction of soft-tissue defects of the head and neck. It consists of skin, subcutaneous tissue, deep fascia, the radial artery, and its accompanying venae comitantes. The flap provides a thin, pliable, and well-vascularized tissue that is particularly suitable for reconstruction of intraoral defects requiring functional mobility.¹⁰

2. Radial Forearm Fascial Flap

The radial forearm fascial flap consists primarily of vascularized deep fascia supplied by the radial artery while preserving the overlying skin. Owing to its minimal thickness, this flap is useful for reconstruction of superficial soft-tissue defects, dural defects, and selected intraoral applications where excessive tissue bulk is undesirable.¹²

An important advantage of this technique is improved donor-site aesthetics, as preservation of the forearm skin often permits primary closure and eliminates the need for skin grafting.

3. Radial Forearm Adipofascial Flap

The adipofascial radial forearm flap incorporates the deep fascia and subcutaneous adipose tissue while preserving the overlying skin. This modification provides a thin, well-vascularized tissue with significantly reduced donor-site morbidity because the skin can frequently be closed primarily.¹²

The technique has been associated with improved cosmetic outcomes, reduced tendon exposure, and decreased scar formation, making it an attractive alternative for selected soft-tissue reconstructions.

4. Osteocutaneous Radial Forearm Free Flap

The osteocutaneous radial forearm free flap incorporates a vascularized segment of the radial cortex in addition to the fasciocutaneous component. The osseous segment receives its blood supply through periosteal branches of the radial artery and allows simultaneous reconstruction of both soft-tissue and limited bony defects.^{11,12}

This flap is particularly useful for reconstruction of small mandibular, maxillary, and alveolar defects. However, because harvesting a segment of the radius increases the risk of donor-site fracture and forearm weakness, preservation of at least 40% of the radial cortex and, in selected cases, prophylactic plating are recommended to maintain structural integrity.

Donor Site Morbidity Following Radial Forearm Free Flap Harvest

Despite the widespread acceptance of the radial forearm free flap (RFFF) as a reliable reconstructive option, donor-site morbidity remains its principal disadvantage. The incidence and severity of complications are influenced by several factors, including flap dimensions, harvesting technique, method of donor-site closure, patient-related factors, and postoperative rehabilitation.^{7,8}

1. Wound-Related Complications

Pain

Pain is the most frequently encountered early postoperative complication following RFFF harvest. It usually results from soft-tissue dissection, periosteal manipulation, and skin graft donor-site healing. The severity generally decreases within the first few postoperative weeks with appropriate analgesia and wound care. Persistent pain is uncommon and is usually associated with nerve injury or excessive scar formation.

Delayed Wound Healing

Delayed healing is commonly observed following split-thickness skin graft reconstruction,

particularly in patients with diabetes mellitus, smoking history, malnutrition, peripheral vascular disease, or wound infection. Delayed epithelialization prolongs patient discomfort and increases the risk of secondary complications such as tendon exposure and graft failure.

Skin Graft Failure

Partial skin graft loss represents one of the most frequently reported donor-site complications. Fortunately, most cases heal successfully with conservative wound management and regular dressing changes. Complete graft failure is relatively uncommon but may necessitate secondary skin grafting or local flap reconstruction.

Tendon Exposure

Exposure of the flexor tendons is considered one of the most significant donor-site complications because it delays wound healing and predisposes to infection and impaired hand function. Preservation of the paratenon during suprafascial flap elevation has been shown to significantly reduce the incidence of tendon exposure while improving graft survival.

Wound Infection

Donor-site infection is relatively uncommon but may contribute to graft loss, delayed healing, increased postoperative pain, and prolonged hospitalization. Appropriate surgical asepsis, meticulous hemostasis, and timely antibiotic therapy are essential for prevention and management.

2. Neurological Complications

Sensory Disturbances

Altered sensation over the dorsolateral aspect of the hand and forearm is frequently reported following RFFF harvest due to injury or traction involving the superficial branch of the radial nerve or adjacent cutaneous nerves. Clinical manifestations include numbness, paresthesia, dysesthesia, and reduced tactile sensation. Although most sensory deficits improve gradually with time, complete recovery may not occur in all patients.¹³

Neuroma Formation

Occasionally, injury to superficial sensory nerves may result in painful neuroma formation, leading to persistent pain, hypersensitivity, and functional discomfort. Careful identification and preservation of cutaneous nerves during flap elevation reduce this risk.

3. Functional Morbidity

Reduced Grip Strength

Temporary reduction in grip strength is commonly observed following surgery due to postoperative pain, soft-tissue dissection, edema, and immobilization. Several studies have demonstrated gradual recovery of grip strength during postoperative rehabilitation, with only a small proportion of patients experiencing persistent weakness.

Restricted Wrist Mobility

Restriction of wrist flexion, extension, pronation, and supination has been reported following RFFF harvest, particularly during the early postoperative period. Appropriate physiotherapy and early mobilization significantly improve long-term functional recovery.

Hand Weakness

Harvesting of fascia together with postoperative pain and scar formation may temporarily reduce hand strength. Most patients regain satisfactory hand function within several months following structured rehabilitation.

4. Vascular Complications

Arterial Insufficiency

Although uncommon, arterial thrombosis or vasospasm involving the radial artery may compromise flap perfusion and result in partial or complete flap loss. Thorough preoperative vascular assessment, including Allen's test, careful surgical technique, and meticulous microvascular anastomosis significantly reduce this risk.^{12,13}

Venous Congestion

Venous congestion remains one of the leading causes of early flap compromise. Inadequate venous drainage results in edema, progressive tissue

ischemia, and eventual flap necrosis if not recognized promptly. Early diagnosis and immediate surgical exploration remain essential for successful flap salvage.³

5. Aesthetic Morbidity

Scar Formation

Visible forearm scarring remains one of the most common reasons for postoperative dissatisfaction, particularly among younger individuals and female patients. Hypertrophic scars and widened scars may require silicone therapy, pressure garments, or laser treatment.

Skin Graft Appearance

Split-thickness skin grafts frequently produce color mismatch, contour irregularities, altered pigmentation, and texture differences compared with surrounding skin. These cosmetic limitations continue to represent one of the principal disadvantages of the conventional RFFF.

Hair Distribution Changes

Harvesting hair-bearing skin may result in localized alopecia or altered hair distribution. Although functionally insignificant, these changes may contribute to patient dissatisfaction.

6. Long-Term Sequelae

Chronic Pain

Persistent donor-site pain is relatively uncommon but may occur secondary to nerve injury, neuroma formation, tendon adhesions, or scar contracture. Chronic pain may interfere with occupational activities and reduce quality of life.

Psychosocial Impact

Visible donor-site scarring and residual functional impairment may negatively influence body image, self-esteem, social interaction, and patient satisfaction. Appropriate preoperative counselling is therefore essential when discussing reconstructive options.

Permanent Functional Disability

Although rare, permanent reduction in wrist function or hand strength may occur in patients

who develop severe wound complications, tendon exposure, extensive nerve injury, or pathological fracture following osteocutaneous flap harvest.

Prevention of Donor-Site Morbidity

Several modifications in surgical technique have been proposed to minimize donor-site complications while maintaining flap reliability.⁹ Important preventive measures include:

- Thorough preoperative vascular assessment using Allen's test or Doppler ultrasonography.
- Harvesting the flap from the non-dominant forearm whenever feasible.
- Preservation of the paratenon through suprafascial flap elevation.
- Gentle tissue handling and meticulous hemostasis during flap harvest.
- Selection of an appropriate donor-site closure technique based on flap size and patient factors.
- Use of negative-pressure wound therapy in selected patients to enhance early wound healing.
- Early physiotherapy to restore grip strength, wrist mobility, and overall hand function.
- Regular postoperative follow-up to facilitate early recognition and management of complications.

DISCUSSION

The radial forearm free flap (RFFF) remains one of the most dependable and versatile microvascular flaps for reconstruction of head and neck defects because of its reliable vascular anatomy, long pedicle, thin and pliable skin paddle, and consistently high success rates. Despite these advantages, donor-site morbidity continues to represent its most significant limitation. Although advances in surgical techniques and donor-site management have substantially reduced postoperative complications, donor-site morbidity remains an important determinant of functional recovery, cosmetic outcome, and patient satisfaction.

The findings of the present review indicate that donor-site complications are generally multifactorial and depend on several variables, including flap dimensions, harvesting technique,

donor-site closure method, patient comorbidities, and postoperative rehabilitation. While most complications are minor and resolve with conservative management, delayed wound healing, tendon exposure, sensory disturbances, reduced wrist mobility, and aesthetic dissatisfaction continue to present significant clinical challenges.⁶

Delayed wound healing remains one of the most frequently reported donor-site complications following conventional split-thickness skin graft (STSG) reconstruction. Although STSG remains the preferred method for closure of larger donor defects because of its simplicity and reliability, it is often associated with pigmentation changes, contour irregularities, graft loss, and prolonged healing. Consequently, several investigators have explored alternative donor-site reconstruction techniques aimed at improving both functional and cosmetic outcomes. Full-thickness skin grafts (FTSG), local advancement flaps, V-Y closure techniques, and acellular dermal substitutes have all demonstrated encouraging results in selected patients, particularly when donor defects are relatively small.^{5,7}

Negative-pressure wound therapy (NPWT) has emerged as one of the most promising adjuncts in donor-site management. Clark et al. demonstrated significantly improved patient-reported hand and wrist function during the early postoperative period among patients treated with NPWT when compared with conventional bolster dressings. Similarly, Halama et al. observed faster wound contraction and earlier recovery of grip strength with vacuum-assisted closure; however, long-term functional outcomes and overall complication rates were comparable between treatment groups. These findings suggest that NPWT primarily accelerates early postoperative recovery rather than eliminating donor-site morbidity altogether.⁸

Functional impairment following RFFF harvest has also received considerable attention in the literature. Temporary reductions in grip strength, pinch strength, wrist flexion, extension, pronation, and supination have been consistently reported during the early postoperative period. Judith et al. demonstrated statistically significant reductions in wrist mobility following flap harvest, although most patients experienced gradual improvement with structured physiotherapy. These observations

emphasize the importance of early physiotherapy and patient compliance in restoring hand function.⁸

Patients frequently report numbness, paresthesia, dysesthesia, or altered sensation over the dorsolateral aspect of the hand and forearm. Although these symptoms often improve over time, persistent sensory deficits may affect manual dexterity and overall patient satisfaction. Careful identification and preservation of superficial sensory nerves during flap elevation may help reduce the incidence of neurological complications.¹³

Cosmetic appearance has become an increasingly important consideration as patient-reported outcome measures gain greater importance in reconstructive surgery. Although successful reconstruction of the primary defect remains the principal objective, visible forearm scarring, pigmentation changes, contour deformity, and tendon exposure may negatively affect patient confidence and quality of life.² Giordano et al. demonstrated that a modified V-Y advancement flap combined with a dagger-shaped full-thickness skin graft produced superior cosmetic outcomes and fewer donor-site complications compared with conventional skin grafting techniques. However, such techniques are not universally applicable because larger donor defects often still require split-thickness skin graft reconstruction.^{6,7}

One of the most significant developments in reducing donor-site morbidity has been the introduction of suprafascial flap harvesting. Preservation of the paratenon overlying the flexor tendons facilitates improved skin graft adherence, reduces tendon exposure, and promotes more predictable wound healing without compromising flap vascularity. Several authors have therefore advocated suprafascial dissection as the preferred harvesting technique whenever technically feasible. This modification represents an important advancement in balancing reconstructive reliability with donor-site preservation.⁷

From a clinical perspective, donor-site management should be individualized according to patient age, occupation, comorbidities, cosmetic expectations, defect size, and reconstructive requirements. Meticulous surgical technique, careful preservation of anatomical structures, selection of the most

appropriate donor-site closure method, structured postoperative rehabilitation, and regular follow-up collectively represent the most effective strategy for minimizing donor-site morbidity while preserving the reconstructive advantages of the radial forearm free flap.⁸

CONCLUSION

The radial forearm free flap continues to be one of the most reliable and versatile options for reconstruction of head and neck soft-tissue defects because of its consistent vascular anatomy, excellent tissue characteristics, and high success rates. However, donor-site morbidity remains its principal limitation and may influence postoperative function, cosmetic appearance, and overall patient satisfaction. Contemporary advances in flap harvesting techniques, particularly suprafascial dissection, together with individualized donor-site closure methods, negative-pressure wound therapy, and structured postoperative rehabilitation, have significantly improved donor-site outcomes.¹³ Nevertheless, no universally accepted strategy has been established for minimizing donor-site morbidity, and management should therefore be tailored to individual patient characteristics and reconstructive requirements. Future well-designed prospective studies employing standardized outcome measures are required to establish evidence-based recommendations that optimize both reconstructive success and donor-site preservation.

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