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Case Report

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A step-by-step intraoperative strategy during one-stage reconstruction of an acute electrical burn injury in the neck for superior surgical outcome in India: a case report

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Electrical burn injuries can cause more damage than clinical evaluations initially suggest. The energy waves penetrate from the surface to the deepest layers of tissue, causing extensive harm at every level. The neck is a critical area, both functionally and aesthetically. We present a case involving a young male patient with a severe fourth-degree electrical burn on the neck, who underwent a single-stage debridement and reconstructive surgery. The pectoralis major myocutaneous flap is a versatile option for various head and neck reconstructions. However, if the donor site cannot be closed primarily and requires split-thickness skin grafting, it can result in unsightly scars and deformities. For large flap paddles, it is ideal to reconstruct the secondary defect with locoregional flaps. In this case, we successfully reconstructed the donor site's secondary defect using a contralateral internal mammary artery perforator flap, without resorting to any skin grafts. The early postoperative results demonstrated satisfactory cosmesis, patient satisfaction, and functional outcomes.

Keywords: Electric burns; Neck injuries; Reconstructive surgical procedures; Myocutaneous flaps; Case reports

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INTRODUCTION

Electrical burn injuries, particularly to the vital areas of the neck, cause extensive damage to important anatomical structures such as blood vessels, nerves, glands, and the airway [1–3]. The neck performs crucial functions including phonation and breathing, in addition to providing a range of movements, supporting the cranium, and contributing to aesthetic appearance. Therefore, the objectives of reconstruction in cases of widespread tissue loss in the sub-acute setting are to restore range of motion, provide thin, supple, and resilient tissue coverage with minimal risk of future contracture, and enhance aesthetic appearance [1,3]. There is a variety of reconstruction and resurfacing options for defects in the cervical region, from split-thickness skin grafts (STSG) to locoregional flaps and microvascular free tissue transfer [1–3]. The pectoralis major myocutaneous (PMMC) flap, a long-standing workhorse flap in head and neck reconstructions, can also be used to resurface large defects in the neck. However, harvesting a large skin paddle results in a secondary defect on the anterior chest wall, which often cannot be closed primarily in a desirable manner [4]. Using an STSG to cover the secondary donor site on the chest wall can lead to an unsightly appearance and contour abnormalities that patients may find unacceptable over time. Addressing such secondary chest wall defects with a secondary locoregional flap at the same time can avoid the need for an STSG and achieve a more satisfactory closure.

CASE REPORT

A 24-year-old male manual laborer presented with an immediate history of an electrical burn injury. The incident occurred while he was carrying a metallic (tin) sheet on his right shoulder, holding it with his hands at a construction site. The sheet inadvertently came into contact with a live electrical wire, causing electricity to flow across the upper part of his body— including the head, neck, and trunk—and exit through his foot, as illustrated in Fig. 1A. The worker was rendered unconscious and was quickly transported to the emergency department, where he received initial resuscitation and a primary assessment. He sustained fourth-degree burn injuries to his neck, which extended superiorly to the mentum, inferiorly to the suprasternal notch, and laterally toward the mastoid prominences on both sides, with the right side being more severely affected than the left, as shown in Fig. 1B and C. The lower part of his face was oedematous, and he exhibited stridor and a swollen upper airway upon laryngoscopy. The right paraumbilical area of his abdomen had third-degree burns, and his left hand and right foot had burn exit wounds. Endotracheal intubation was performed, and intravenous fluids were initiated. Over the following week, he was stabilized in the intensive burn care unit. Plans were made for debridement of the neck wound and primary reconstruction.

Under general anesthesia and in a supine position, all necrotic tissue from the neck and abdomen (specifically the paraumbilical area) was debrided. This resulted in a neck defect measuring 13 cm × 10 cm, with bilateral exposure of the sternocleidomastoid muscles and thyroid cartilage, extending laterally towards the mastoid prominences. The right submandibular gland was also affected and subsequently removed (Fig. 2A). A reverse planning approach was utilized, and a butterfly-shaped 13 cm × 10 cm PMMC skin paddle was designed. This design avoided the deltopectoral flap territory and preserved the nipple-areolar complex on the right side (Fig. 2B, C). Skin incisions were made and deepened to include the pectoralis major muscle. The pedicle on the undersurface, which is the pectoral branch of the thoracoacromial vessels, was visualized (Fig. 2D–G). A subcutaneous tunnel was created in the deltopectoral territory, and the flap was transferred and rotated 90° clockwise to fill the neck defect. The flap was inset in two layers over a suction drain, and the secondary defect from the PMMC harvest was reduced to a 10 cm × 8 cm area (Fig. 2H, I). The necrotic area in the right paraumbilical region was debrided, leaving an 8 cm × 6 cm defect, which was then closed primarily (Fig. 2I).

Subsequently, a decision was made either to perform skin grafting on the secondary defect site or to opt for local tissue re-

Fig. 1. Images of the patient. (A) The mode of electrical injury, which occurred while the patient was carrying a metal (tin) sheet that came in contact with a live electrical wire, causing current to flow through the upper part of the body (lower face, neck, trunk, left hand towards the inferior part with the exit wound at the foot). (B) The patient presented to the emergency department with facial and neck oedema before resuscitation. (C) The patient was transferred to the burn center intensive care unit and intubated during assessment. The patient provided written informed consent for publication of the clinical images.

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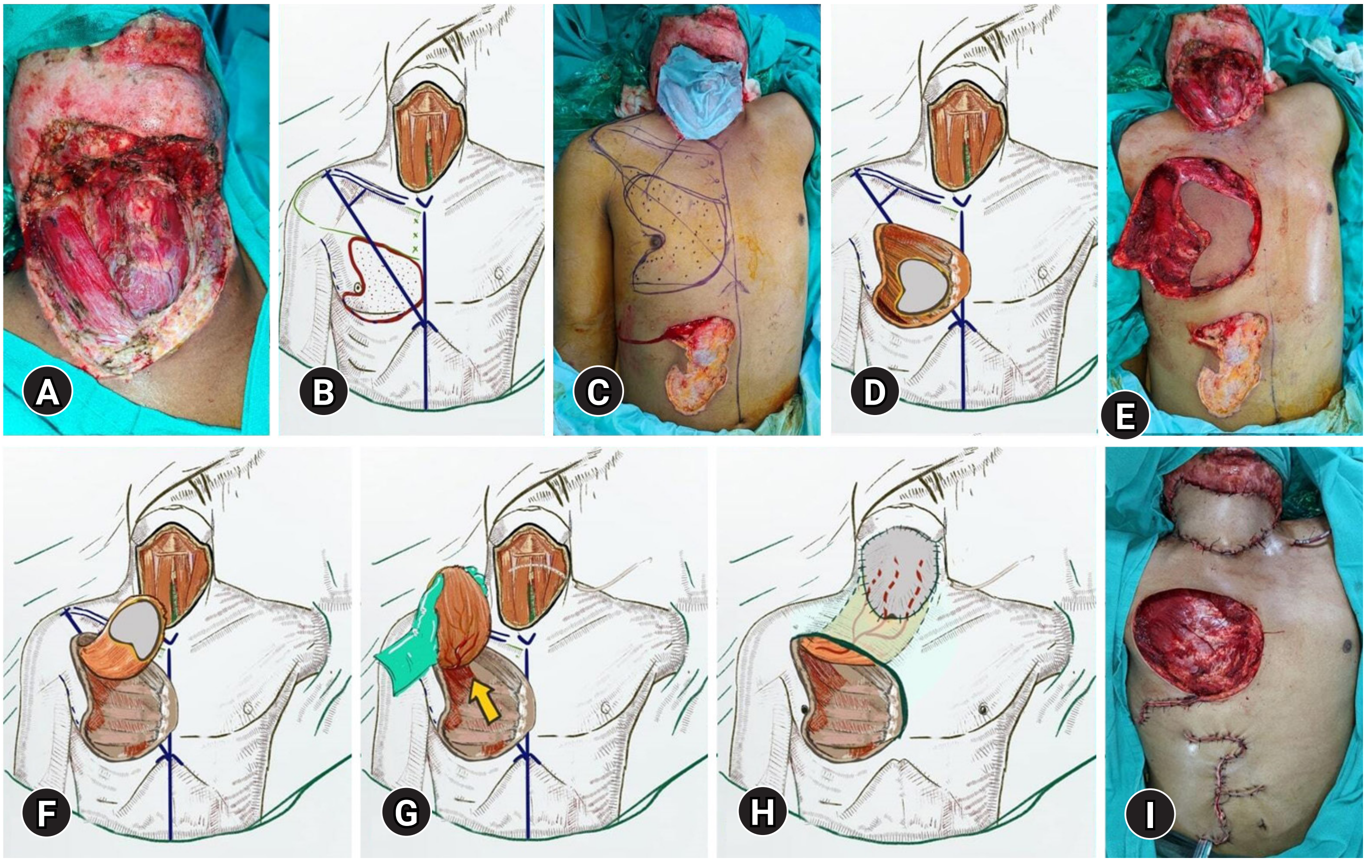

Fig. 2. Diagrams and images of the neck wound. (A) The neck wound after debridement. (B, C) Diagram and image of the reverse planning of the butterfly-designed pectoralis major myocutaneous flap to resurface the primary neck defect. (D, E) Diagram and image of the flap harvest. (F, G) Diagrammatic views of the flap transfer subcutaneously to the neck defect. (H, I) Diagram and image of the flap inset with partial closure of the secondary defect, also showing the periumbilical defect closure after debridement.

arrangement. The latter was chosen for its superior durability and aesthetic outcome. Consequently, a contralateral (left-sided) flap based on the second and third internal mammary parasternal perforators, which were identified with intraoperative Doppler, was designed. Incisions were made to elevate the flap in the subfascial plane (Fig. 3A–C). Using loupe magnification, meticulous dissection of the medial aspect of the flap was carried out to preserve the second and third internal mammary perforators. The flap was then islanded and rotated 150° anticlockwise to fit into the secondary defect left by the harvested PMMC flap. It was inset in two layers over a separate suction drain, as depicted in Fig. 3D and E. The tertiary defect of the internal mammary artery (IMA) perforator flap was closed primarily in two layers with minimal undermining (Fig. 3F–H). No skin grafts were utilized.

The patient was initially cared for in the burn intensive care unit before being transferred to the burns ward. One week later, the drains were removed, and early mobilization commenced. Two weeks after admission, the sutures were taken out, and he was discharged with instructions for weekly outpatient department follow-ups (Fig. 4A–D). He successfully regained near-normal neck mobility without encountering significant difficulties or major complications during subsequent follow-ups (Fig. 4E–H).

Ethics statement

The patient provided written informed consent for publication of the research details and clinical images.

DISCUSSION

The severity of an electrical burn—determined by factors such as the type of current, voltage, duration of contact, temperature, and the regions affected, including the entry and exit wounds—dictates the depth and extent of tissue damage and subsequent com-

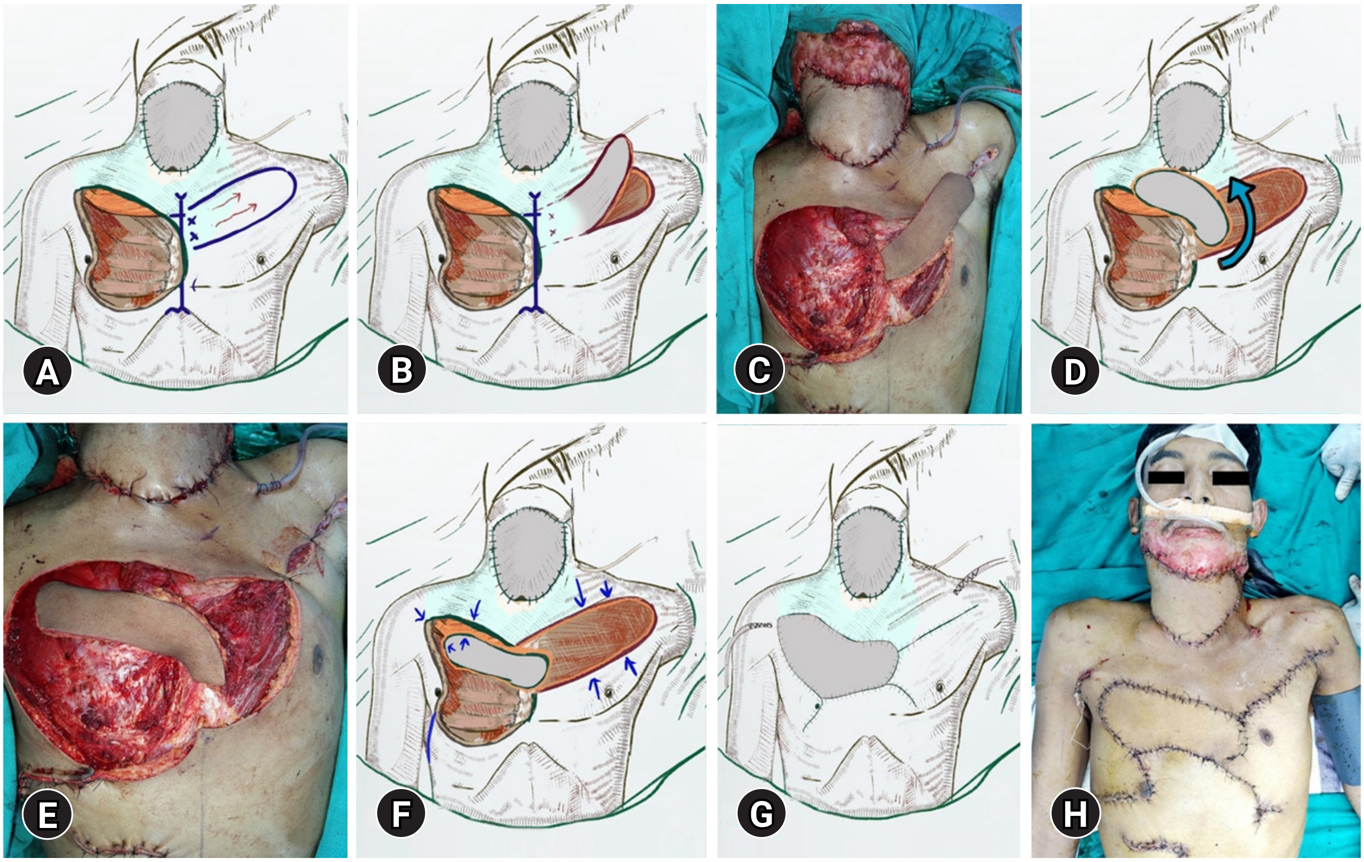

Fig. 3. Diagrams and images of the neck wound. (A–C) Diagrams and image of the plan for resurfacing the secondary defect after pectoralis major myocutaneous (PMMC) flap harvest using a contralateral (left-sided) internal mammary artery (IMA)-islanded perforator flap based on the second and third parasternal IMA perforators identified using Doppler ultrasonography intraoperatively; (D–F) Diagrams and image showing the rotation of the islanded IMA perforator flap into the secondary defect (of the pectoralis major myocutaneous flap). (G, H) Diagram and image after IMA flap inset and primary closure of the tertiary defect area. The patient provided written informed consent for publication of the clinical images.

plications. The resulting coagulative necrosis of tissues disrupts the cell membrane's resting potential, leading to periosteal necrosis at the bones (points of greatest resistance) and muscle involvement. This can cause rhabdomyolysis and compartment syndrome in acute cases. Without appropriate resuscitation, the affected area can expand according to Jackson's burn wound model, creating an opportunity for pathogen invasion and subsequent sepsis. Therefore, aggressive debridement in the sub-acute phase, following resuscitation and stabilization, is crucial. This may be performed in stages, with or without the use of negative pressure wound therapy, and is a necessary precursor to any reconstructive strategy [4,5].

The neck is a critical region of the body, housing essential anatomical structures such as vessels (including the carotid, jugular, and subclavian), nerves (such as the vagus, phrenic, and the roots of the brachial plexus), glands (including the thyroid and submandibular salivary glands), as well as the airway and esophagus. It provides both structural and functional support to the cranium and enables a broad range of movements, including flexion, extension, rotation, and lateral bending within the sagittal and coronal planes. Consequently, the addition of tissues is often required in the event of skin defects in both the anterior and lateral regions of the neck. The restoration of the cervicomental angle, which is located at the level of the hyoid bone and serves as a pivot point for the suprahyoid and infrahyoid subunits, is critically important [1–3].

Several surgical reconstructive options, such as STSG, local and regional pedicled flaps, microvascular free tissue transfer, and preexpanded adjacent normal local tissue rearrangements (including rotation, advancement, transposition, and interpolation), are well-documented in the literature [1–3]. The lateral neck, supraclavicular areas, anterior chest wall, and even the back can serve as potential donor sites for local tissue transfer to repair anterior neck defects [1–4,6–8]. Supraclavicular flaps, which are

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Fig. 4. Postoperative images of the patient. (A–D) Postoperative status of the wounds after 3 weeks, with the patient performing active head and neck movements. (E–H) Postoperative follow-up 6 weeks after the injury with near normal neck extension and healed wounds. The patient provided written informed consent for publication of the clinical images.

refinements of cervicodeltopectoral flaps (with or without preexpansion), can provide an excellent match in color and contour for neck reconstruction when they are available [6,7]. Similarly, microvascular tissue transfers using thin anterolateral thigh (ALT) flaps and groin flaps have been employed to provide supple, thin, and resilient tissue coverage, facilitated by the easy availability of recipient vessels nearby [1,2]. However, locoregional flaps offer the advantage of transferring tissue that more closely matches the original site in terms of color, texture, and aesthetic acceptability [1,3,6–8].

The PMMC flap is a versatile reconstructive option for various head and neck defects, offering numerous advantages such as a large cutaneous paddle, robust blood supply, ample soft tissue volume, an easy learning curve, short operative time, and quick recovery. It also provides a wide arc of rotation. This flap is particularly ideal for severe burns, including third- and fourth-degree injuries such as electrical flash burns, where it is crucial to cover a large defect area and obliterate significant dead space [4].

In our case, the patient presented with a large neck defect following debridement (13 cm transverse and 10 cm longitudinal) that exposed critical structures such as the sternocleidomastoid muscle, carotid sheath, thyroid cartilage, and the right side of the mandible. This exposure occurred after radical debridement of the superficial burnt skin, platysma, right-sided submandibular glands, and deep cervical fascia. Several reconstructive options were considered, including free tissue microvascular structures like the ALT flap or pedicled tissues such as the supraclavicular or deltopectoral flaps bilaterally. However, due to extensive bilateral involvement of the lateral neck and damage to the transverse cervical artery (the basis of the supraclavicular artery supplying the supraclavicular flap territory), as well as tributaries of the external and internal jugular veins with the facial and lingual vessels (potential recipient vessels for free tissue microvascular transfer), these options were deemed risky, if not impossible. Additionally, the operative time needed to be minimized from an anesthetic standpoint. Delaying reconstruction to a secondary stage with open wound management was not an option due to the risk of carotid or jugular blow-out. Deltopectoral flaps were insufficient to cover the entire defect, even if used bilaterally. Furthermore, the defect was not suitable for skin grafting due to the exposed vital structures and mandible in the sub-acute stage of inflammation.

A right-sided PMMC flap was planned with a bilobed or butterfly design, positioned medial to the nipple-areola complex in a vertical fashion, creating a parabolic arc around the areola that connected the two crests of the flap. This design aimed to resurface the neck defect to match its size and shape, a technique previously reported for ALT flaps [2]. After harvesting and transferring the flap, and tunnelling under the spared right-sided deltopectoral skin, adjustments were made to mobilize the lateral neck tissue with bilateral Z-plasties for a tension-free inset on the primary defect. However, the secondary defect from the PMMC flap was too large for primary closure, which would have been preferable for such anterior chest wall defects. The defect was reduced to a 10 cm oblique by 8 cm longitudinal size after lateral undermining. At this juncture, an STSG over the secondary defect was considered, but due to the rib contours, this option would likely have resulted in a poor aesthetic outcome and potential for partial graft loss. Facing a ground zero situation once again, this time with the PMMC donor site, a contralateral (left-sided) flap based on the second and third IMA perforators was planned to match the dimensions of the secondary defect (10 cm × 8 cm). The flap was islanded and transposed to the defect in a counter-clockwise direction for 150°, and the tertiary defect of the IMA flap was closed primarily. This approach provided a satisfactory cover over the anterior chest wall, avoiding the need for a skin graft entirely.

These IMA perforator flaps, which are refinements of deltopectoral flaps, have been described for the reconstruction of various defects in the chest wall, trachea, and pharynx, as well as for the closure of tracheoesophageal fistulae. They are relatively easy and quick to harvest, and allow primary closure of the donor site [9,10].

The total duration of the operative procedure was 4 hours and 30 minutes, with an estimated blood loss of 500 mL. The patient experienced a rapid and uneventful recovery, with no significant complications during the early postoperative period. He was discharged 2 weeks after surgery following the removal of sutures and was scheduled for weekly follow-ups for 2 months. Neck extension was satisfactory, reaching 100°, as measured with a goniometer (Fig. 4F), and lateral flexion and rotation were nearly within normal limits. Aside from a widened scar at the IMA perforator flap donor site, the aesthetic outcomes were well-received.

Reconstructive procedures are numerous and adaptable. They are carefully evaluated and selected based on the nature, type, and location of the defects, as well as the underlying disease—akin to choosing the correct card at the right moment. In challenging cases, selecting the appropriate method from the array of established procedures is crucial for achieving optimal results, with patient safety as a paramount consideration. Additionally, a step-by-step approach to addressing multiple problems sequentially, often during surgery (focusing on the most pressing issue at a time), is vital. The management of the donor site is also of great importance, guided by the principle "Borrow from Peter to pay Paul, but only when Peter can afford it." If not, Peter has to take a loan from others!

ARTICLE INFORMATION

Author contributions

Conceptualization: MM; Formal analysis: MM; Investigation: MVSR; Methodology: SKG, KKDP; Visualization: MM, SKG; Writing–original draft: MM, SKG; Writing–review & editing: all authors. All authors read and approved the final manuscript.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Data availability

Data sharing is not applicable as no new data were created or analyzed in this study.

REFERENCES

1. Akita S, Hayashida K, Takaki S, Kawakami Y, Oyama T, Ohjimi H. The neck burn scar contracture: a concept of effective treatment. Burns Trauma 2017;5:22.
2. Lellouch AG, Ng ZY, Pozzo V, Suffee T, Lantieri LA. Reconstruction of post-burn anterior neck contractures using a butterfly design free anterolateral thigh perforator flap. Arch Plast Surg 2020;47:194–7.
3. Zhang YX, Wang D, Follmar KE, et al. A treatment strategy for postburn neck reconstruction: emphasizing the function-

https://doi.org/10.20408/jti.2023.0075

al and aesthetic importance of the cervicomental angle. Ann Plast Surg 2010;65:528–34.
4. Balraj DJ, Singh M, Sood P. Use of pectoralis major myocutaneous flap cover in a case of electric burn. Int Surg J 2020;7:4247–9.
5. Zemaitis MR, Foris LA, Lopez RA, Huecker MR. Electrical injuries [updated 2023 Jul 17]. In: StatPearls [Internet]. StatPearls Publishing; [cited 2023 Sep 9]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK448087/
6. Ducic Y, Smith JE. The cervicodeltopectoral flap for single-stage resurfacing of anterolateral defects of the face and neck. Arch Facial Plast Surg 2003;5:197–201.
7. de Carvalho FM, Correia B, Silva A, Costa J. Versatility of the supraclavicular flap in head and neck reconstruction. Eplasty 2020;20:e7.
8. Davis JC, Bordeaux JS, Love WE. Repair of a lateral neck defect using a trilobed transposition flap. Dermatol Surg 2014;40:323–6.
9. Iyer NG, Clark JR, Ashford BG. Internal mammary artery perforator flap for head and neck reconstruction. ANZ J Surg 2009;79:799–803.
10. Yu BT, Hsieh CH, Feng GM, Jeng SF. Clinical application of the internal mammary artery perforator flap in head and neck reconstruction. Plast Reconstr Surg 2013;131:520e–526e.