

Radiation-induced skin changes are commonly seen in patients who have been treated for head and neck malignancies. Some of these skin changes can progress into chronic postradiation ulcers, which despite aggressive medical wound management will not resolve spontaneously. Skin grafts and local cutaneous flaps located within the radiation field are unreliable and rarely provide adequate stable coverage. In this article, the authors report a combined experience of 52 patients whose postradiation cervical ulcers were successfully and reliably treated with myocutaneous flaps.

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## RECONSTRUCTION FOR CERVICAL IRRADIATION ULCERS WITH MYOCUTANEOUS FLAPS

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**R**adiation damage to normal tissue is well documented and is one of the unpreventable side effects often seen when tumoricidal doses of radiation are administered to treat carcinoma of the head and neck. Fortunately, the damage to normal tissue usually is limited to local radiation dermatitis or mucositis. These minor reactions respond to topical therapy, and resolve over a period of weeks.<sup>1</sup> A difficult problem arises when skin necrosis and subsequent ulceration occurs. Radiation ulceration can obviously develop when radiation is used alone or when used in combination with surgery, because it is dependent on both the total "dose" and the fragility of the irradiated tissue, and may develop either with the pre- or post-surgical irradiation therapy. When such a disruption of the wound occurs, and it does not promptly respond to aggressive medical therapy, the term "irradiation ulcer" is used.

To blame only irradiation for all failures of wound healing is overly simplistic. Wound break-

down or ulceration can develop in both nonirradiated and irradiated tissues because of technical mistakes, excessive wound tension, infection, or residual tumor. The fact remains, however, that once an ulcer develops in an irradiated zone, irrespective of the cause, the treatment of such an open wound is an extremely complex surgical problem.

### PATIENTS AND METHODS

Over the past 7 years we have treated 52 patients with large radiation ulcerations of the head and neck region. All these patients were initially treated for a malignant process and the majority had undergone combination therapy with either pre- or postoperative irradiation. All of the patients included in this series had received at least 5,000 rad of external beam radiation within the ulceration field, and numerous patients were known or suspected to have received more than 10,000 rad. Some of the ulcerations contained residual tumor, either identified on gross examination prior to reconstruction or found postoperatively in the microscopically studied tissue sent to pathology after debridement. A period of 3 months was allowed from the time the initial ulceration developed to the time reconstruction was undertaken. During this period, the patient was carefully watched by both the surgeon and the radiation therapist for signs of spontaneous recovery. The exception to this rule is the patient who is in imminent danger from massive hem-

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orrhage or who demonstrates recurrent tumor. In these situations, surgical reconstruction was promptly initiated.

Six of the 52 patients studied responded well to conservative therapy and were successfully treated with either local skin flaps or skin grafts. The remaining 46 patients required more extensive reconstructive procedures.

In this group, the final debridement and reconstruction procedures were accomplished in a single stage with the use of a myocutaneous flap. The series includes 27 pectoralis major myocutaneous flaps, 13 trapezius myocutaneous flaps, and 6 latissimus myocutaneous flaps.

In all cases requiring flap reconstruction, the irradiation ulceration was cultured for both aerobic and anaerobic organisms preoperatively, and quantitative biopsies were obtained prior to reconstructive procedures. All of the wounds were found to be contaminated with a mixed flora, especially when the ulceration communicated with the oral cavity or pharynx. Appropriate antibiotic therapy was administered immediately prior to surgical intervention, as dictated by the culture sensitivity reports, and the wounds were chemically and mechanically cleansed preoperatively using a variety of topical agents. Preparation of the ulcer prior to flap reconstruction included immediate, aggressive wound debridement with removal of all devitalized tissue.

Two case reports are used to illustrate the typical clinical presentation these patients exhibit.

**Case Reports.** *Case 1.* This patient is a 62-year-old black woman who received 6,200 rad (CO<sup>60</sup>) followed by total laryngectomy, partial pharyngectomy, and dissection of the left side of the neck. The immediate postoperative period was followed by massive wound breakdown, pharyngocutaneous fistula, loss of the skin flap of the neck, and exposure of the carotid artery (Fig 1A). Prior to her transfer to our institution, an attempt to close the wound with an ipsilateral pectoralis major flap was attempted, and failed. Because of the imminent danger of carotid hemorrhage, reconstruction was undertaken upon arrival using the opposite pectoralis major myocutaneous flap (Fig. 1B and C). The procedure consisted of radical debridement of all scars and radionecrotic tissue, closure of the fistula, and immediate coverage with a 20 × 10 cm pectoralis paddle. The postoperative period was uncomplicated, and the patient left the hospital completely healed in 2 weeks. (Fig. 1D)

*Case 2.* Case 2 is a 58-year-old black woman

who had undergone an unknown but extensive amount of external radiation 15 years previously to treat a lymphoma limited to the left side of the neck. Over the past 5 years she developed a chronic nonhealing wound in the radiation portal (Fig. 2A). A biopsy of the ulcer showed a small focus of squamous cell carcinoma in addition to radiation fibrosis and endarteritis. A contralateral trapezius myocutaneous flap was delayed 2 weeks prior to the definitive reconstructive procedure (Fig. 2B).

The irradiation ulcer was widely excised with controlled margins, and the flap was elevated and inset (Fig 2C).

The donor site required skin grafting. Three weeks following reconstruction, there was excellent wound healing around the flap, good mobility of the neck, and no further signs of ulceration (Fig. 2D).

## RESULTS

One-stage myocutaneous flap reconstruction for large postradiation ulcerations of the head and neck has proven successful in a series of 46 treated patients. Our surgical complication rate was 13%, which was related to one instance of complete loss of a latissimus flap secondary to an overwhelming infection and five instances of partial flap necrosis that required either readvancement of the flap or skin grafting the underlying (flap) muscle. This complication rate is significantly below the 43% reported by Rudolph in his 1982 report.<sup>2</sup> The ulcerations healed and remained healed in 45 of 46 patients. The single failure was in the case of the last latissimus flap, and further efforts were abandoned for medical reasons.

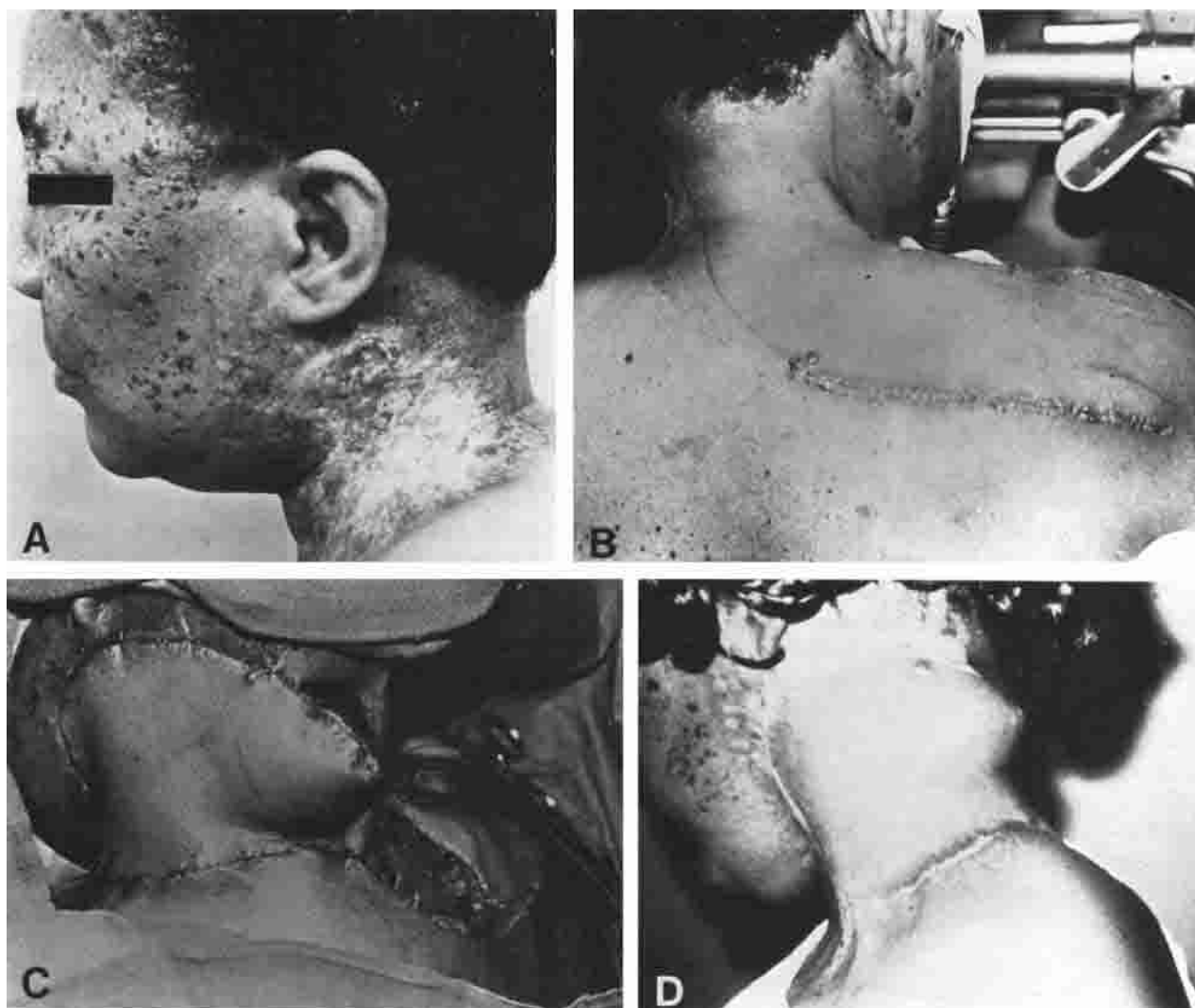
## DISCUSSION

Since the introduction of irradiation as a treatment for malignant head and neck tumors, radiation therapists and physicists have made significant advances in treatment protocols and delivery techniques. Unfortunately, the growing use of radiation therapy and the necessary combined use of radiation therapy and surgery has maintained the incidence of postradiation ulcers.<sup>3</sup>

One year after the introduction of x-rays in 1895, the destructive effects of radiation were noted. Since that time, radiologists, radiotherapists, and surgeons have remarked on the nature of the undesirable effects of ionizing radiation. In 1926, Ewing<sup>4</sup> first reported on the vascular insult caused by radiation. More recently, the electron



**FIGURE 1.** Case 1. **(A)** Large pharyngocutaneous fistula and exposed carotid artery in postradiation surgical breakdown. Note the large area to be resected within the marking. **(B)** Right pectoralis "paddle" flap to be used for reconstruction. Note the "too far" medial scar on the left side of the chest from the previously attempted, left pectoralis flap which was unsuccessful. **(C)** Pectoralis "paddle" designed below the right breast in the inframammary crease measuring 10 × 20 cm. **(D)** The patient 4 weeks following radical debridement of the radiation ulcer, closure of the fistula, and coverage with the pectoralis major myocutaneous flap, demonstrating good wound healing and complete recovery.



**FIGURE 2.** Case 2. (A) Patient with a large chronic radiation-induced ulceration of the entire left side of the neck with biopsy-proven squamous cell carcinoma. The patient was originally treated for a lymphoma. (B) A contralateral horizontal trapezius myocutaneous flap has been delayed 2 weeks prior to the reconstruction. (C) Wide resection of the radionecrotic ulcer has been accomplished, and coverage restored with the trapezius myocutaneous flap. The large donor defect required skin grafting. (D) Three weeks after reconstruction the patient is healing satisfactorily and shows no signs of further ulceration.

microscope has demonstrated that radiation damages the ultrastructure of cells, resulting in cytoplasmic malfunctions.<sup>5</sup> The combination of obliterative endarteritis and chronic ischemia has made the radionecrotic ulcer one of the most challenging wounds to treat successfully.<sup>2</sup> The lack of normal wound healing and contraction caused by delayed myofibroblast function are also factors in irradiated wounds. In addition to the tissue effects of irradiation, other factors contribute to the poor wound healing seen in postradiation ulcers, such as repeated local wound contamination by various microorganisms. One must also consider

recurrent or residual tumor at the wound margins and the nutritional status of the patient.

Plastic surgeons have long struggled to treat postradiation wounds, but with the advent of megavoltage units capable of delivering radiation deep into the soft tissue while sparing the skin, the nature of irradiation ulcers changed. When radiation wounds occurred after megavoltage therapy, it became evident that the skin had sustained a major insult, and conservative superficial debridement and coverage with skin grafts would not suffice as adequate treatment.<sup>6</sup> Skin graft failure rates of near 100% were often re-

ported. Local random flaps were frequently attempted; however, these flaps were usually based at the ulcer's edge, were themselves within the radiation field, and were often too small to reconstruct a large defect. Distal pedicled flaps, which brought in nonirradiated tissue, provided the surgeon with an effective means of reconstruction,<sup>7</sup> but multiple stages required prolonged hospitalization. The development of cutaneous axial pattern flaps, such as the deltopectoral and forehead flaps, was a significant advance in head and neck reconstruction,<sup>8</sup> and offered the reconstructive surgeon an alternative means of resurfacing a postradiation defect. Their usefulness cannot be denied.

With the advent of the myocutaneous principle, the treatment of large irradiation ulcers and defects of the head and neck has changed dramatically.<sup>9, 10</sup> The numerous myocutaneous flaps that are useful in the head and neck region, namely, the pectoralis major, the horizontal and vertical trapezius, and the latissimus dorsi are capable of providing the volume of required tissue to reconstruct virtually any defect.<sup>11-13</sup> This knowledge has enabled us to treat the ulcerative area with a more radical debridement than was formerly possible. When such a wide resection and debridement are performed, the flap can be inset into a healthy bed well away from the original ulcerative area, circumventing the problem of wound disruption related to avascularity.<sup>2</sup> Myocutaneous flaps are supplied by large blood vessels<sup>14</sup> that usually have not been subjected to the harmful effects of irradiation, thus the myocutaneous flap may then actually promote the healing process in the irradiated tissue. The superior vascularity of myocutaneous flaps, when compared to random pattern flaps, also contributes to the flap's inherent resistance to bacterial contamination from the radiation wound and oral cavity.<sup>15</sup>

We feel that the following precautions taken prior to definite surgery are just as important as the decision to use the proper flap:

1. All of our patients were treated with a combination of preoperative broad spectrum, systemic antibiotics and aggressive local wound care.<sup>16</sup>
2. In most cases, despite the fact that surgical debridement of the ulcerative tissue was planned, bacteria counts below  $10^5$  were achieved prior to surgical reconstruction by aggressive local wound care.
3. The nutritional status of the patient was carefully monitored prior to surgery. Preoperatively, the patients were brought into a positive nutritional balance, and maintained in good balance in the postoperative period. Those patients who presented in negative nutritional balance or with large fistulae were continued on parenteral hyperalimentation until complete healing had occurred or until they were able to sustain themselves orally.

**Summary.** A 7-year combined experience that treated 52 patients with irradiation ulcerations of the head and neck has been reviewed. Our policy of aggressive local wound care, nutritional support, followed by radical debridement and immediate reconstruction using myocutaneous flaps has resulted in the successful treatment of 46 patients with a major complication rate of 13%.

We feel that all postradiation ulcers that fail to heal spontaneously despite adequate medical therapy should be widely resected and covered with well-vascularized muscle and skin. Myocutaneous flap coverage has proved to be reliable and efficient reconstruction for large postradiation head and neck ulcers and defects.

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