Medical Journal of the
Islamic Republic of Iran

Volume 15
Number 4
Winter 1380
February 2002

PEDICLE MUSCLE FLAPS IN IRRADIATED WOUNDS: DOES PREVIOUS RADIATION OF THE MUSCLE TO BE TRANSPOSED AFFECT THE OUTCOME? A 9 YEARS EXPERIENCE OVER 206 CONSECUTIVE CASES

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ABSTRACT

Radiation-related wounds challenge surgeons in all disciplines of surgery. Wound-healing complications are commonplace, and solutions for reconstruction are limited. Muscle and musculocutaneous flaps have improved this situation. But the question is, does previous radiation of the muscle to be transposed affect the outcome?

143 consecutive previously irradiated patients treated with muscle or musculocutaneous flaps composed the group under consideration: these 143 patients had 206 muscles transposed. The overall complication rate for muscle transposition to close a radiated wound was 20 percent.

Of the 143 patients who received radiation, 62 patients had the muscle transposed for wound closure from the primary field of radiation. 81 patients were closed with non-irradiated muscle. When the transposed muscle had been radiated, the complication rate was 29.6 percent; in 14.3 percent, the entire muscle underwent necrosis, requiring total removal and a second tissue transposition from a non-irradiated source to achieve closure. The subgroup using non-irradiated muscle had a complication rate of 12.2 percent; 1 patient in this group had complete flap necrosis requiring a second tissue transposition. No postoperative deaths were encountered.

The experience in our department reveals that non-irradiated muscle is the best choice for closure of a radiated wound, if possible.

MJIRI, Vol. 15, No. 4, 189-193, 2002.

Keywords: Irradiation, Muscle flap, Muscle transposition.

INTRODUCTION

Radiation therapy is a valuable form of treatment for a wide variety of primary and recurrent malignancies. Although local control of the tumor is improved, this is accompanied by long-term qualitative effects of fibroblasts and myofibroblasts in conjunction with mitochondrial damage and inhibition of wound contraction.[1,2] Vascular changes have also been documented to include endothelial proliferation, subintimal fibrosis, and reduction in the vessel lumen, which could lead to thrombosis [3,4]. The reconstructive surgeon is often faced with a difficult wound, a hopeless patient and a history of multiple previous non-operative and operative failures.

Brown et al.[5] Presented a classic report in 1949 outlining the clinical stages of chronic radiation injury. Their description of atrophy, telangiectasis, "coal spots", keratosis, and carcinoma remains accurate. When presented with chronic ulcers, their recommendation called for the use of adjacent or distant delayed flaps. Later, as their experience expanded, they demonstrated that in order to achieve healing, non-irradiated, well-vascularized tissue had to be brought into the radiated field.[6]

In 1961, Masters and Robinson[7] reported their experience in 169 cases over 14 years and recommended that chronic radiation injury is best treated with uninvolved tissue from outside the primary field of radiation. However, a more recent report has stated that radiation to the transposed muscle's nutrient vessels does not compromise flap viability. Regarding current experiences, this has not been the case.[8] In light of this controversy, and some unsatisfactory results, the experience in our department was reviewed during the last 9 years with muscle transposition for closure of radiated wounds. We specifically compared our results when the transposed muscle was in the primary field of radiation versus when non-irradiated muscle was used.

MATERIAL AND METHODS

From June 1991 through June 2000, 407 tissue transpositions were performed in 377 patients on a single surgical service (Saint Ali-Asghar Hospital). Patients who had a recurrent malignancy, were receiving chemotherapy or were currently taking steroids, or had used steroids within the previous year were excluded from this initial group of patients. The first 206 consecutive previously irradiated wounds closed with either muscle or musculocutaneous flaps were reviewed.

Table I. Location of wounds.

Location	No. of patients
Chest wall	35
Sternum	31
Breast	21
Buttock	9
Perineum	8
Groin	9
Head and neck	7
Upper extremity	2
Lower extremity	20
Total patients	142

In group A (91 patients), the muscle transposed was in the primary field of radiation. In group B (115 patients), the transposed muscle was non-irradiated.

The median time period from the last course of radiation to the day of surgery was 3.4 years with a range of 2 months to 8 years. A radiation therapist reviewed the patients included in the study to determine the field of radiation and its relation to the transposed muscle. All patients had received radiation therapy for the treatment of malignant disease. The average age in each group was comparable: group A, 41 years; group B, 44 years.

Although a wide variety of wounds was seen, in 42 percent the upper trunk was reconstructed (Table I).

In almost 50 percent of cases, the latissimus dorsi or pectoralis major was used (Table II).

All procedures were performed in a single surgical service by the same primary surgeon, thus ensuring consistency of surgical technique. Consecutive patients were chosen to minimize the effect of operator experience and reduce the bias of patient selection.

All complications were assessed by the same surgeon and noted. The charts of ali patients included in the study were reviewed by the same investigator. Partial or full muscle necrosis was defined as requiring operative debridement. Partial skin graft loss was judged significant when debridement and regrafting were required. Wound infections were confirmed by culture of the organism involved. The procedure was deemed a complete failure when the transposed muscle suffered complete necrosis, necessitating total excision followed by a second tissue transposition to achieve closure. In our series, all clo-

Table II. Tissue transposed.

Muscle	Number	Percent
Latissimus dorsi	56	27.2
Pectoralis major	44	21.4
External oblique	11	5.3
Gluteus maximus	10	4.8
Rectus abdominis	12	5.8
Trapezius	4	1.9
Pectoralis minor	9	4.4
Gracilis	12	5.8
Gastrocnemius, medial	13	6.3
Gastrocnemius, lateral	16	7.8
Tensor fasciae latae	14	6.8
Deltoid	2	0.9
Temporalis	3	1.5
Total	206	100

sures were completed with tissue transposition; methods of management of radiation-induced wounds with non-viable transposed primary muscle, by a secondary muscle is shown in Table III. Free tissue transfer was not required.

RESULTS

The overall complication rate for muscle transposition in a radiated field was 20 percent. This is compared with a complication rate of 7.8 percent in our series of 512 patients operated on by the same surgeon over the same time period requiring muscle transposition which had never received radiation therapy.

For the 206 patients who received radiation, the transposition of a radiated muscle was associated with a complication rate of 29.6 percent. However, when a non-irradiated muscle was used, the complication rate was 12.2 percent. The incidence of hematoma, seroma, infection, and fistula were comparable in both groups (Table IV).

However, when evaluated specifically for failure of the transposition, there were 13 complete failures (14.3 percent) when radiated muscle was used. These required total excision of the transposed radiated muscle and a second tissue transposition for closure. There was 1 complete failure when a non-irradiated muscle was transposed. The transposition of a non-irradiated muscle eventually resulted in primary healing in all but 1 patient. This difference is significant by Fisher's exact test ($p<0.0004$).

There was no mortality in both groups. The average hospital stay was 17 days when non-irradiated tissue was used, compared with 2-6 days when radiated muscle was used. The length of stay was analyzed by using an independent group t-test. The t value of 5.3 was highly significant ($p<0.0002$). This difference is attributed to the higher rate of post-operative complications when radiated muscle was used.

DISCUSSION

The radiated wound has been recognized as a challenging problem by surgeons for over 47 years. Cellular and non-cellular changes, combined with the progressive nature of radiation damage, caused us to modify our approach when treating a radiation injury. The single most important consideration in the treatment of radiation wounds is adequate debridement.[9-11] This can exceed original estimates of the area involved and require multiple procedures. In many instances, a wound that appears healthy in the operating room after fresh debridement shows continuing necrosis the following day. For

Table III. Methods of management of radiation-induced wounds with non-viable transposed primary muscle, by a secondary muscle.

Radiation status of muscle transposed	Primary muscle transposed	Site of wound	Secondary muscle transposed	Number
Irradiated	Tensor fascia lata	Perineum	Gracilis	2
	Medial gastrocnemius	Leg	Lateral gastrocnemius	2
	Lateral gastrocnemius	Leg	Medial gastronemius	1
	Pectoralis major	Sternum	Latissimus dorsi	5
	Pectoralis major	Sternum	Rectus abdominis	3
Non-Irradiated	Latissimus dorsi*	Sternum	Rectus abdominis	

*This failure seems to be due to shortness of the vascular pedicle resulting in intimal damage during transposition and inevitable tension.

Table IV. Complications.

Radiation status of muscle	Full muscle necrosis	Partial muscle necrosis	Hematoma	Seroma	Infection	Fistula	Total
Non-irradiated muscle (Group A) (n= 115)	1 (0.9%)	2 (1.7%)	- (0%)	3 (2.6%)	3 (2.6%)	5 (4.4%)	(12.2%)
Irradiated muscle (Group B) (n= 91)	13 (14.3%)	1 (1%)	2 (2.2%)	3 (3.3%)	4 (4.4%)	4 (4.4%)	(29.6%)

this reason, we delay wound closure until the wound has clearly demonstrated, 24 to 48 hours after the last debridement, that a stable, healthy wound margin has been established. Despite aggressive attempts, in most instances the surgeon is still faced with some degree of radiation damage in the area of concern, with relative ischemia. At this time, we rely on the transposed muscle to provide a well vascularized tissue source to augment the wound healing process.

This only works when the blood supply to the edges of the debrided wound is only compromised and not absent. Transposed muscle will not, in our experience, "resuscitate" non-viable tissue.

It has been our experience that when the transposed muscle has been irradiated, failure of the procedure is increased. The viability of the muscle in these cases does not appear compromised at the time of the original procedure; however, in most cases a combination of necrosis and infection lead to failure. In 4 patients, this required further debridement and transposition of the muscle from outside the field of radiation. All patients were eventually discharged with a closed wound.

The cause of complete failure of the transposed muscle is likely to be multifactorial; however radiation appears to be a significant factor. In our group of 512 non-irradiated patients, there were only 4 patients in whom transposition resulted in complete necrosis of the muscle, a rate of 0.8 percent. This compared with a complete necrosis rate of 29.6 percent when radiated muscle was transposed. This represents a greater than 37-fold increase in full muscle necrosis when radiated muscle was used.

The ability of muscle and musculocutaneous flaps to resist bacterial inoculation and clear residual infection is a clear advantage in chronic open wounds. the progressive vascular damage and cellular injury associated with radiation appears to reduce the advantage of muscle transposition when the muscle has been in the primary field of radiation.

REFERENCES

1. Rudolph R, Arganese T, Woodward M: The ultrastructure and etiology of chronic radiotherapy damage in human skin. Ann Plast Surg 9: 282, 1982.
2. Reinisch J, Puckett C: Management of radiation wounds. Surg Clin North Am 64: 795, 1984.
3. Fajardo LF, Berthrong M: Radiation injury in surgical pathology. Part I. Am J Surg Pathol 2: 159, 1978.
4. Luce EA: The irradiated wound. Surg Clin North Am 64: 821, 1984.
5. Brown JB, McDowell F, Fryer MP: Surgical treatment of radiated burns. Surg Gynecol Obstet 88: 609, 1949.
6. Brown JB, McDowell F: Application of permanent pedicle blood carrying flaps. Plast Reconstr Surg 8: 335, 1951.
7. Masters FW, Robinson DW: Early operation, a conservative approach to the treatment of chronic irradiation injury. J Trauma 1: 583, 1961.
8. Larson DL, McMurtrey MJ: Musculocutaneous flap reconstruction of chest wall defects: an experience with 50 patients. Plast Reconstr Surg 73: 734, 1984.
9. Woods JE, Arnold PG, Masson JK, Irons GB, Payne WS: Management of radiation necrosis and advanced cancer of the chest wall in patients with breast malignancy. Plast Reconstr Surg 63: 235, 1979.
10. Arnold PG, Pairolero PC: Surgical management of the

radiated chest wall. Plast Reconstr Surg 77: 605, 1986.
11. Arnold PG, Pairolero PC: Reconstruction of the radiation damaged chest wall. Surg Clin North Am 69: 1081, 1985.