AJNR

MR Imaging of the Muscular Component of Myocutaneous Flaps in the Head and Neck

June Chong, Ling Ling Chan, Howard N. Langstein and Lawrence E. Ginsberg

AJNR Am J Neuroradiol 2001, 22 (1) 170-174
http://www.ajnr.org/content/22/1/170

AJNR Am J Neuroradiol 22:170–174, January 2001

MR Imaging of the Muscular Component of Myocutaneous Flaps in the Head and Neck

June Chong, Ling Ling Chan, Howard N. Langstein, and Lawrence E. Ginsberg

BACKGROUND AND PURPOSE: **Myocutaneous flaps are commonly used for reconstruction in head and neck surgery. The purpose of this study was to characterize the MR imaging findings of the muscular component of these flaps, with an emphasis on enhancement patterns. Recognition of these imaging findings is important in differentiating postoperative changes from recurrent tumor.**

METHODS: **MR studies were evaluated in 25 patients who had undergone 27 flap reconstructions after resection of a head and neck tumor. Twenty were free flaps and seven were pedicled rotation flaps, and a dominant component of all flaps was muscle. MR images were reviewed for signal intensity, enhancement characteristics, and morphology over a period of 7 to 79 months.**

RESULTS: **On baseline postoperative images, 21 flaps showed moderate or intense enhancement of the muscular graft component relative to nonenhancing native muscle, three flaps showed mild enhancement, and three showed no enhancement. On follow-up images, 18 flaps that initially had intense enhancement showed persistent intense enhancement, and three showed decreasing enhancement. Two flaps with initial mild enhancement were unchanged on follow-up, and one became nonenhancing. None of the initially nonenhancing flaps subsequently enhanced. T1 signal intensity of muscular graft components was always isointense with normal muscle, whereas T2 signal intensity was variable and tended to be stable. Ninety-three percent of our muscular flap components showed striations typical of normal muscle and were best identified on T1-weighted images. No significant imaging differences were found between pedicled and free flaps.**

CONCLUSION: **Most muscular flap components show moderate or intense enhancement on fat-suppressed contrast-enhanced MR images that may persist for many months and be quite striking. Radiologists should be familiar with the typical postoperative appearance of predominantly muscular flaps to avoid misdiagnosis as tumor extension or recurrence.**

Myocutaneous flaps are used in head and neck tumor surgery for repairing surgical defects, restoring optimal function, and cosmesis. After tumor extirpation and surgical reconstruction, there is often significant anatomic distortion, making the detection of tumor recurrence by physical examination difficult. For the radiologist, postoperative imaging evaluation of these flaps can be challenging. Knowledge of the surgical procedure and expected imaging appearance of the neck after surgery is essential for differentiating tumor recurrence from postoperative changes. Our study describes the MR imaging features of the muscular component of myocutaneous flaps.

Methods

We retrospectively reviewed our records to identify head and neck reconstructive flaps that were either purely or predominantly muscular, or those in which a significant component of the graft was muscular. From these, we evaluated a total of 80 postoperative MR examinations in 25 patients with 27 predominantly muscular myocutaneous flaps. Seventeen patients were male and eight female, with ages ranging from 12 to 80 years (mean age, 51 years). All patients had undergone head and neck tumor resection and surgical flap reconstruction. Two patients each underwent two surgical procedures with two separate flap reconstructions. These two patients had tumor recurrence at a site remote from the initial surgical bed that did not involve the original reconstruction flap. All flaps were clinically viable. Patient data, including flap type, appear in the Table. Only patients with clinical and radiologic stability, without clinical or radiologic evidence of tumor recurrence involving the flap on follow-up examinations, were included in the

Received February 3, 2000; accepted after revision June 5.

Presented at the annual meeting of the American Association of Head and Neck Radiology, San Diego, CA, May 1999.

From the Departments of Radiology (J. C., L. L. C., L. E. G.) and Plastic and Reconstructive Surgery (H. N. L.), The University of Texas M. D. Anderson Cancer Center, Houston, TX.

Address reprint requests to Lawrence E. Ginsberg, MD, M. D. Anderson Cancer Center, Department of Radiology, Box 57, 1515 Holcombe Blvd, Houston, TX 77030.

MR imaging findings in 25 patients with flap reconstructions after resection of a head and neck tumor

Case No.	Age (y)/Sex	Reconstruction Flap	Enhancement	T2 Signal Intensity	Length of Disease-Free Follow-up (m)
1	60/M	RAM free flap	3+, persisted	Hyperintense	40
2	70/M	RAM free flap	1+ → NE	Isointense	79
3	56/F	RAM free flap	2+, persisted	Hyper → isointense	33
4	50/M	RAM free flap	2+, persisted	Hyperintense	25
5	71/M	RAM free flap	3+, persisted	Hyperintense	28
6	67/M	RAM free flap	2+, persisted	Hyperintense	7
7	64/M	RAM free flap	2+, persisted	Hyperintense	14
8	37/F	RAM free flap	NE	Hypointense	23
9	39/F	RAM free flap	3+, persisted	Hyperintense	38
10	32/F	RAM free flap	2+, persisted	Hyperintense	38
11	22/F	RAM free flap	2+, persisted	Hyperintense	31
12	65/M	RAM free flap	2+, persisted	Hyperintense	29
13	56/M*	RAM free flap,	NE	Hypointense	36
		pectoralis major rot. flap	NE	Hypointense	17
14	17/M*	Temporalis rot. flap,	2+, persisted	Isointense	35
		RAM free flap	2+, persisted	Hyperintense	20
15	51/F	RAM free flap	2+, persisted	Hyperintense	13
16	69/M	RAM free flap	2+, persisted	Mixed	12
17	66/M	Trapezius rot. flap	2+ → NE	Mixed	13
18	50/M	Temporalis rot. flap	3+ → 1+	Hyperintense	30
19	48/F	RAM free flap	1+, persisted	Hyperintense	10
20	48/M	RAM free flap	1+, persisted	Hyperintense	13
21	80/M	RAM free flap	2+, persisted	Hyperintense	39
22	56/M	Temporalis rot. flap	3+, persisted	Hyperintense	18
23	21/F	Latissimus dorsi free flap	3+ → 2+	Hyperintense	11
24	12/M	Temporalis rot. flap	3+, persisted	Hyper → isointense	20
25	61/M	Temporalis rot. flap	3+, persisted	Isointense	14

* Tumor recurrence at site remote from previous surgical bed, not involving first reconstruction flap.

Note.—RAM indicates rectus abdominis; rot, rotational; 1+, mild enhancement; 2+, moderate enhancement; 3+, intense enhancement; NE, nonenhancement.

study. The duration of disease-free follow-up after surgery was 7 to 79 months (mean, 24.5 months).

The study population included 20 myocutaneous free flaps (19 rectus abdominis muscle and one latissimus dorsi free flap), and seven pedicled rotation flaps (five temporalis, one pectoralis major, and one trapezius muscle rotation flaps). Because the head and neck surgery service did not have a standard schedule for obtaining postoperative imaging examinations during the period of this study, the time between surgery and the baseline MR examination was highly variable. The intervals ranged from 4 days to 2 years 3 months (mean, 4 months) between surgery and baseline imaging. The MR examinations were reviewed retrospectively by two experienced neuroradiologists.

MR imaging features evaluated included the presence and degree of enhancement, the T2-weighted signal intensity relative to normal muscle, and the morphology of the muscular component (ie, the presence of muscular striation). Degree of enhancement was judged on an agreed-upon scale of mild (1+), moderate (2+), and intense (3+) determined by consensus reading. All MR examinations were performed on 1.5-T units. Axial and coronal noncontrast T1-weighted (400–660/9–15 [TR/TE]) images and T2-weighted (3700–6000/105 [TR/TE_{eff}]) images with fat suppression, as well as axial and coronal fat-suppressed, contrast-enhanced (0.1 mmol/kg) T1-weighted images were reviewed. These were obtained at 3- to 5-mm sections with a 1.0- to 1.5-mm gap, and a 16- to 18-cm field of view.

Results

Imaging data are summarized in the Table. Twenty-one (78%) of the 27 flaps showed moderate or intense enhancement of the muscular component relative to nonenhancing native muscle (Figs 1–3). Eighteen of these showed persistent moderate or intense enhancement at follow-up, while the remaining three showed decreased enhancement on follow-up. Enhancement tended to persist even in the face of atrophy of the muscular graft component (Fig 3). Three flaps (11%) had mild enhancement, one of which became nonenhancing on follow-up. Three flaps were persistently nonenhancing (Fig 4). Striation of the muscular component was noted in 93% of the flaps, and was best seen on noncontrast T1-weighted sequences (Figs 1 and 4), although it was also seen on other sequences (Figs 1, 2, and 4). The initial T2 signal characteristics of the muscular graft component were variable, ranging from hypointense (three flaps) to isointense (three flaps), to hyperintense (19 flaps) as compared with native muscle (Figs 1 and 2). In two cases, the T2 signal intensity was mixed. The T2 signal intensity tended to be stable, except for two cases in which initial T2 signal hyperintensity converted to an isointense appearance. There was no statistically significant difference between pedicled and free flaps in terms of enhancement, T2 signal, or tendency to appear striated.

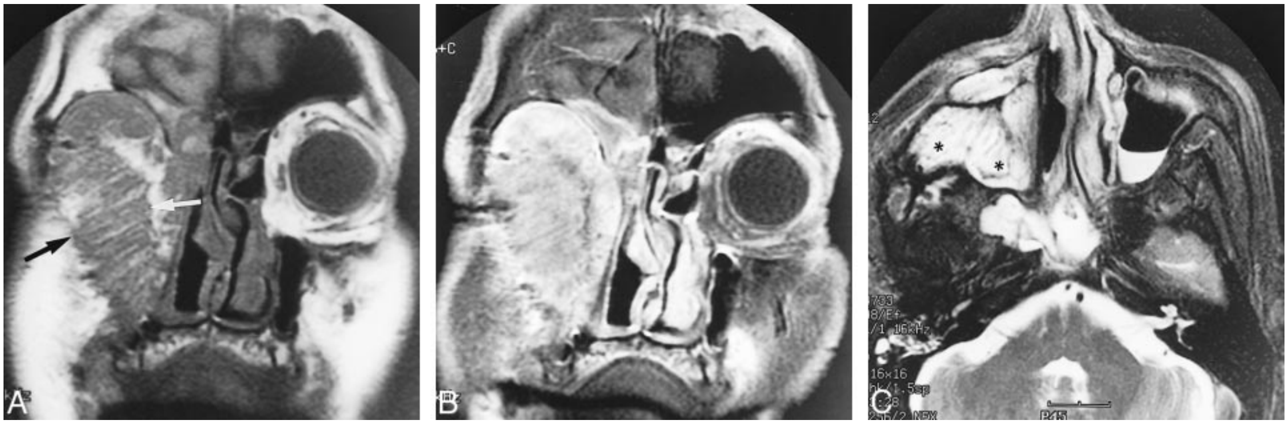

FIG 1. 50-year-old man with adenoid cystic carcinoma of the maxillary sinus. MR images were obtained 2 months after right orbital exenteration, radical maxillectomy, and rectus abdominis free flap reconstruction.

A, Coronal noncontrast T1-weighted (400/9/2) image shows typical striations within the large muscular flap (*arrows*) occupying the orbitomaxillary defect.

B, Contrast-enhanced, fat-suppressed T1-weighted (583/9/2) image shows bright enhancement of the muscular flap component.

C, Axial fast spin-echo T2-weighted (4733/98/2) image with fat suppression shows signal hyperintensity of the muscular flap component (*asterisks*). Though less evident than on the T1-weighted sequence, muscular striations can be seen on this image.

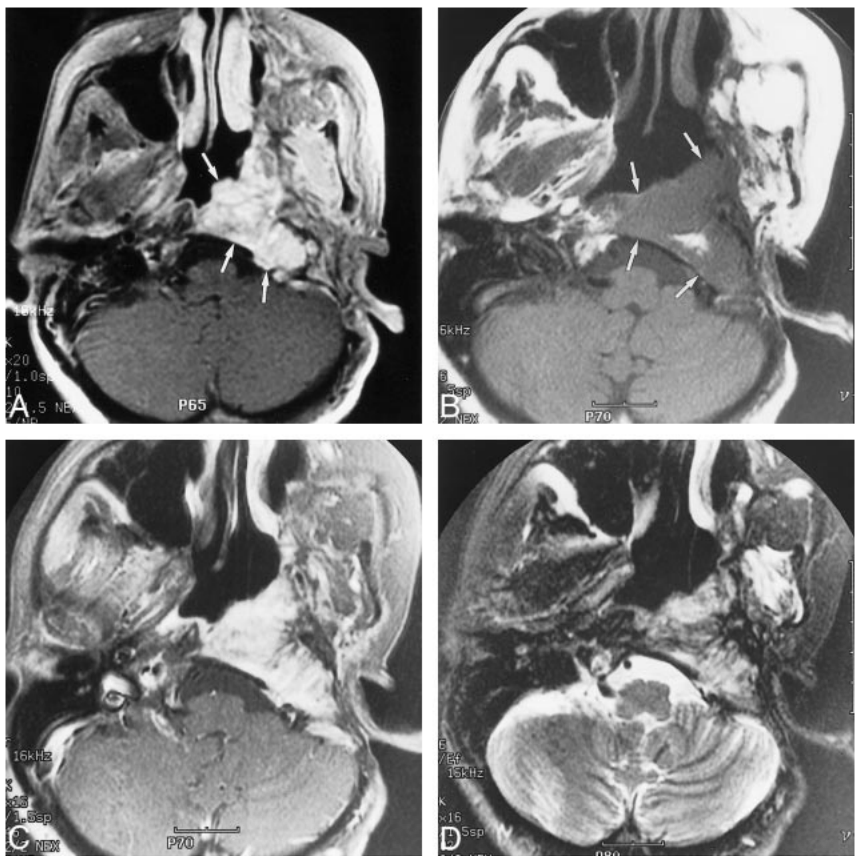

FIG 2. 39-year-old woman with neurofibrosarcoma of the nasopharynx and central skull base after resection and placement of a rectus abdominis free flap. This case illustrates persistent enhancement and absence of atrophy of a muscular graft over several years.

A, Contrast-enhanced, fat-suppressed T1-weighted (600/16/1.5) image obtained several months postoperatively shows bright enhancement of the graft in the nasopharyngeal region (*arrows*).

B–D were obtained 3 years after surgery.

B, Axial noncontrast T1-weighted (500/9/2) image shows a soft-tissue structure representing a nearly purely myogenous graft in the central skull base (*arrows*). Striations are only faintly seen centrally.

C, Contrast-enhanced, fat-suppressed T1-weighted (583/9/2) image shows bright enhancement of the graft. Internal heterogeneity is caused largely by striations. Because of the enhancement, this graft was repeatedly misinterpreted as persistent tumor over the course of several years by numerous radiologists. No tumor recurrence has ever been documented in this operative site. Note the similarity with *A,* obtained 3 years earlier.

D, Axial fast spin-echo T2-weighted (4733/98/2) image with fat suppression shows only moderate signal hyperintensity of the graft. Striations are apparent on this sequence.

Discussion

Reconstructive techniques after surgical resection of head and neck tumors commonly involve muscle-based flaps for restitution of function and cosmesis (1). Myocutaneous flaps are composite flaps, composed primarily of muscle with the overlying skin and subcutaneous tissue. Broadly speaking, flaps are either pedicled or free. Pedicle flaps are local or regional muscles that are kept attached only by their vascular pedicle and rotated into the defect, where they are configured for the particular purpose. The pectoralis major and trapezius myocutaneous flaps are the two commonly used pedicled rotation flaps in head and neck reconstruction after oncologic surgery. The temporalis flap is also a pedicled, but predominantly myogenous, flap that receives its blood

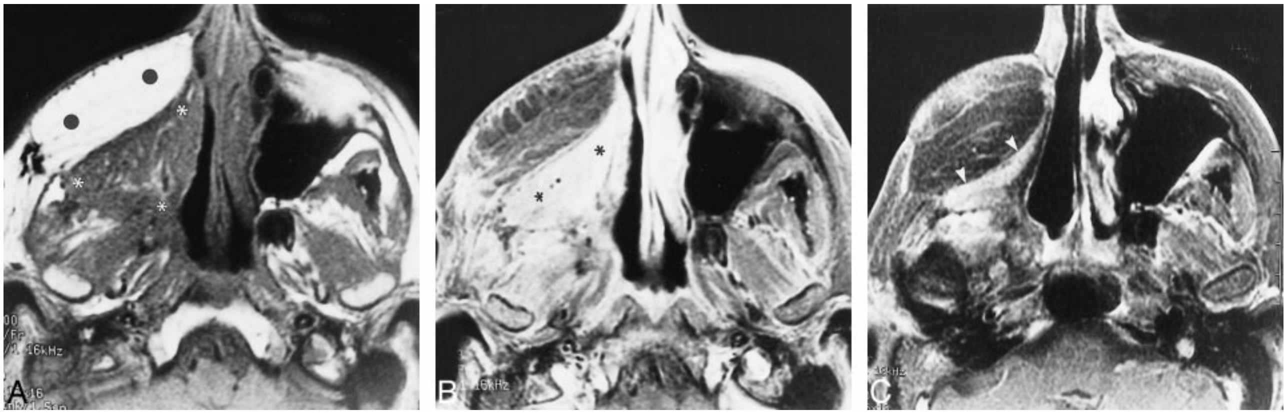

FIG 3. 51-year-old woman after radical maxillectomy and orbitectomy for poorly differentiated squamous cell carcinoma of maxillary sinus origin and placement of a large rectus abdominis free flap. This case illustrates persistent enhancement and subsequent flap atrophy.

A and *B* were obtained 4 months after surgery.

A, Axial T1-weighted (400/9/2) image shows an anteriorly situated fatty component (*black dots*) and a posteriorly situated muscular component with internal striations (*asterisks*).

B, Contrast-enhanced, fat-suppressed T1-weighted (450/9/2) image shows signal suppression in the fatty component and bright enhancement of the muscular component (*asterisks*).

C, Contrast-enhanced, fat-suppressed T1-weighted (583/9/2) image obtained 9 months after *A* and *B* shows persistent enhancement of a much smaller, atrophied muscular graft component (*arrowheads*). The size of the fatty component is unchanged.

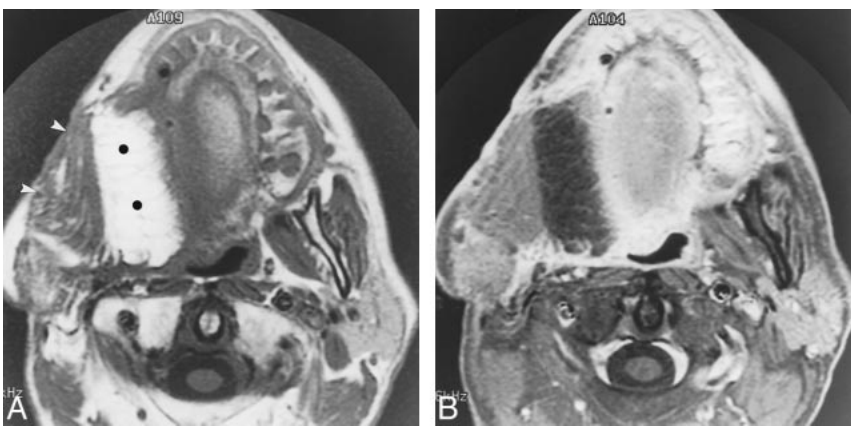

FIG 4. 56-year-old man after resection of a high-grade sarcoma of the masticator space and placement of a pectoralis rotational flap. Imaging studies were obtained 2 months postoperatively. This case illustrates nonenhancement of the muscular graft component.

A, Axial T1-weighted (450/9/2) image shows a medially situated fatty graft component (*black dots*) and a laterally situated muscular graft component with obvious striations (*arrowheads*).

B, Contrast-enhanced, fat-suppressed T1-weighted (583/9/2) image shows signal suppression of the fatty component and no enhancement of the muscular graft component.

supply from the deep temporal vessels and is usually used in skull base reconstruction.

Free flaps (or microvascular free tissue transfer) are distant units of tissue that are harvested with a vascular pedicle. The entire flap is transferred with or without the overlying skin to the head and neck defect, where they are revascularized by microsurgical anastomosis to recipient site vessels, generally the external carotid artery and internal jugular vein, or, if the flap pedicle is not long enough, branches of those vessels. Free flaps are typically chosen for larger, more complicated defects, as in the majority of our cases, because they allow more flexibility in the transfer of greater amounts of tissue. The rectus abdominis and latissimus dorsi muscles are frequently used free flaps in head and neck reconstructive surgery because they are reliable and provide adequate tissue bulk (1).

MR imaging is now widely used for the postoperative evaluation of head and neck cancer, particularly after major procedures involving the skull base, orbit, and sinonasal cavity. Its excellent contrast resolution and tissue differentiation allow early detection of tumor recurrence. It is critical that the radiologist interpreting these complex studies be familiar with the nature of the surgery performed as well as with the expected postoperative appearance, not only to detect recurrence but also to avoid misdiagnosing normal graft tissue as diseased.

Several reports have described the imaging appearance of reconstructive flaps in the head and neck (1–5). The majority concern CT or MR imaging with respect to the fatty component of the graft. To our knowledge, no previous reports have focused mainly on the postcontrast MR imaging appearance of the muscular component of myocutaneous flaps.

In their report on postoperative tumor recurrence, Hudgins et al (5) described the MR imaging findings of myocutaneous flaps in six patients. They found the noncontrast T1 and T2 signal intensity of muscular flap components to be isointense with normal muscle. We also found T1 signal isointensity between muscular flaps and normal muscle, although in our series, the T2 signal intensity was variable and mostly hyperintense.

Naidich and Weissman (6) showed an example of a contrast-enhancing temporalis rotational flap, and stated ''it is normal for flap muscles to enhance.'' However, that point was not referenced, and may not be widely known. Of three patients in the series by Hudgins et al (5) imaged after contrast administration, only one muscular flap component was noted to enhance. Our higher rate of occurrence of muscular enhancement may be partly explained by a larger study group and partly by the use of fat suppression in our postcontrast sequence, a technique known to be associated with greater conspicuity of enhancement.

As Hudgins et al (5) astutely observed, since ''tumor and flap may enhance, gadolinium-enhanced MR images may not predict (tumor) recurrence accurately.'' We concur that enhancement of the muscular component of a myocutaneous flap might easily be misinterpreted as tumor, particularly when that enhancement is in proximity to or contiguous with the original site of disease, or when there is tumor recurrence nearby. In fact, in one of our cases (Fig 2), enhancement of a purely muscular flap was repeatedly interpreted as ongoing tumor before its benign nature was determined. However, we submit that a thorough knowledge of the type of procedure performed and familiarity with the expected postoperative appearance should limit this type of misinterpretation. In addition, the presence of muscular striations, best seen on the T1-weighted images but also on the other sequences, was always associated with an intact and nondiseased muscular graft in our series.

We are uncertain why muscle that in its native location enhances minimally or not at all should enhance when rotated or otherwise transferred to a new location. Removing a muscle results in significant vascular disruption, even in the case of a rotational flap, because distal vessels are likely to be separated. When placed into the recipient site, there is presumably some recruitment of neovascularity to more peripheral aspects of the graft, those farthest from the vascular anastomosis. We suspect that with vascular disruption and neovascularization, there is sufficient alteration of normal flow dynamics such that contrast material is forced into the extravascular space of the muscle, allowing for the observation of enhancement.

Another contributing factor in the enhancement of a grafted muscle is denervation. Free flaps are of course completely denervated. Pedicled rotational flaps are often intentionally denervated by the surgeon so as to prevent inappropriate twitching. In an article by Davis et al (7), in situ denervated masticator muscles showed increased enhancement. Their proposed explanation included increased blood flow, which is known to occur in denervated muscle, and increased extracellular space, which would be expected in an atrophying muscle. Similar findings were reported by Russo et al (8). A grafted muscle cannot be precisely compared with a denervated muscle in situ, yet some of these mechanisms may contribute to the enhancement we observed in our patient group.

We initially set out to study the atrophy patterns in muscular flaps; however, because we did not have early baseline postoperative MR examinations in all patients, we considered the data to be unreliable, and do not report those findings here. We did, however, notice that despite denervation, most of the muscular flap components did not atrophy over time (Fig 2), an observation that is seemingly at odds with all previous descriptions of flap behavior: Deschler and Hayden (1), Som et al (2), Wester et al (3), and Naidich and Weissman (6) all state that the muscular component of a flap can be expected to atrophy. We hope to address this issue with further study.

Conclusion

Baseline postoperative imaging with sequential comparison studies is essential in the complete follow-up of patients undergoing head and neck flap reconstruction. Interval stability or a decrease in any soft-tissue fullness favors postoperative changes over recurrent tumor. A sound understanding of the type of reconstructive surgery done and the anticipated postoperative imaging appearance of myocutaneous flaps further aid in accurate diagnosis of tumor recurrence, allowing earlier intervention while avoiding unnecessary biopsy and therapy. The radiologist should also be aware that the majority of myocutaneous flaps show enhancement of the muscular component, and not mistake it for tumor recurrence. The presence of muscular striation on noncontrast T1-weighted sequences can also help distinguish normal flap architecture from tumor recurrence.

References

1. Deschler DG, Hayden RE. **Head and neck reconstruction.** *Neuroimaging Clin N Am* 1996;6:505–514
2. Som PM, Urken ML, Biller HF, Lidov M. **Imaging the postoperative neck.** *Radiology* 1993;187:593–603
3. Wester DJ, Whiteman MLH, Singer S, Bowen BC, Goodwin WJ. **Imaging of the postoperative neck with emphasis on surgical flaps and their complications.** *AJR Am J Roentgenol* 1995;164:989–993
4. Som PM, Biller HF. **Computed tomography of the neck in the postoperative patient: radical neck dissection and the myocutaneous flap.** *Radiology* 1983;148:157–160
5. Hudgins PA, Burson JG, Gussack GS, Grist WJ. **CT and MR appearance of recurrent malignant head and neck neoplasms after resection and flap reconstruction.** *AJNR Am J Neuroradiol* 1994;15:1689–1694
6. Naidich MJ, Weissman JL. **Reconstructive myofascial skull-base flaps: normal appearance on CT and MR imaging studies.** *AJR Am J Roentgenol* 1996;167:611–614
7. Davis SB, Mathews VP, Williams DW. **Masticator muscle enhancement in subacute denervation atrophy.** *AJNR Am J Neuroradiol* 1995;16:1292–1294
8. Russo CP, Smoker WRK, Weissman JL. **MR appearance of trigeminal and hypoglossal motor denervation.** *AJNR Am J Neuroradiol* 1997;18:1375–1383