En bloc subtotal temporal bone resection for cancer of the external ear

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The authors report their technical experience with the en bloc subtotal temporal bone resection of cancer of the external ear involving the temporal bone. With the cooperation of an experienced plastic surgery team, coverage of the large defect with a rotation flap makes this procedure successful by wound healing per primam. Complications such as hemorrhage, vascular thrombosis, and brain abscess can be minimized by strict application of neurosurgical and plastic surgery techniques. Two successful cases are described in detail.

KEY WORDS: en bloc subtotal temporal bone resection, cancer of external ear, rotation scalp flap, cancer of temporal bone

It is generally believed that carcinoma of the external ear, once it has extended to involve the temporal bone, carries an extremely poor prognosis. This pessimism stems from the difficulty encountered both in early precise diagnosis and in the complete extirpation of the tumor.

This tumor may spread to various vital structures closely associated with the temporal bone (Fig. 1). It may extend through the squamous portion of the bone to involve the dura, trigeminal nerve, and cavernous sinus. If the tumor gains access to the middle ear, it may penetrate the thin roof of the chamber into the middle fossa, or it may extend to the inner ear, and, still further, to the brain stem. Once intracranial, it may extend posteriorly to involve the lateral sinus and the lower cranial nerves. From the middle ear it may travel down the Eustachian tube to the nasopharynx. Direct extension to the infratemporal region may surround the great vessels. Finally, distant metastasis may occur.

Various measures have been used to treat cancer in this location. As early as 1899 Heyer described piecemeal removal of the temporal bone for carcinoma. In general, the results of surgery for these tumors were so discouraging that radiotherapy was adopted as a preferable mode of treatment. Campbell and associates in 1951 suggested, however, that the principle of en bloc resection might be applied. It was in 1954 that the first en bloc resection was reported by Parsons and Lewis. Using this technique, Coleman performed en bloc resection in seven cases and summarized his long-term results in 1966, showing a 42% survival at 5 years. Operative morbidity and mortality were still quite high.

At the Medical University of South Carolina, we have found that by utilizing a two team approach, en bloc subtotal

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Fig. 1. Schematic drawing of routes of carcinomatous extension.

temporal bone resection can be a safe and effective means for the treatment of advanced cancer of the external ear. The authors would like to describe the details of this operative procedure performed jointly by neurosurgical and plastic surgery teams.

Case Reports

Case 1

On January 2, 1969, a 51-year-old man was admitted for treatment of drainage from a skin cancer of the right ear which had been present for 2 years (Fig. 2). He was otherwise asymptomatic, and he had not had previous treatment.

Examination. A 1 x 1.5 cm infiltrating ulcerated lesion had replaced the tragus of the right ear. The tumor extended into the external auditory meatus, overlay the right temporomandibular joint and parotid gland, and was fixed to the temporal bone. There were several 1 x 0.5 cm upper jugular lymph nodes. Skull films, temporal bone tomograms, and nasopharyngoscopy were all negative. Biopsy of the tumor showed basal cell carcinoma. Because of the clinical evidence of bone involvement, it was decided to remove the tumor by en bloc resection of the temporal bone, external ear, and surrounding soft tissue structures.

Operation. On January 22, 1969, the lesion was approached through a circular incision about the right ear (Fig. 3 left). Dissection was begun inferiorly with transection of the sternocleidomastoid muscle and then carried deeply, preserving the internal carotid artery and vagus and hypoglossal nerves. Biopsy of lymph nodes proved negative. The internal jugular vein was divided and all soft tissue was cleared up to the base of the skull. The ascending ramus of the mandible and zygomatic arch were transected. The digastric and stylopharyngeus muscles were divided next to their attachments to the skull base.

The remainder of the circular incision was now completed above and behind the ear through the temporal, parietal, and occipital scalp to the skull. After placing burr holes, the squamous portion of the temporal bone was removed as in the approach to the Gasserian ganglion (Fig. 3 right). The floor of the middle fossa was also removed to the foramen spinosum. Two burr holes were then placed posteriorly next to the transverse sinus, one in the posterior temporal area and the other in the suboccipital area, and connected by removal of bone with a rongeur, thus crossing the transverse sinus. Bone removal was continued from the suboccipital burr hole.

Fig. 2. Case 1. Preoperative photograph of lesion.
inferiorly and anteriorly until the jugular foramen was reached. The suboccipital muscles were divided, and the sigmoid sinus was protected and crossed during this maneuver. As the removal of bone progressed, the dura was separated from the groove of the transverse sinus, then from that of the sigmoid sinus and finally from the petrous ridge. Numerous emissary veins draining into these sinuses were carefully coagulated and cut. The separation of the dura finally reached a point just lateral to the porus acusticus.

The last stage consisted of sagittal transection of the petrous portion at the arcuate eminence by means of a broad osteotome. This was done cautiously to prevent injury to the carotid artery. To avoid undue pressure on the brain, mannitol solution was administered and cerebrospinal fluid was drained through a lumbar puncture.

At the termination of this excision by the neurosurgical team (Fig. 4 upper left), the wound presented a large expanse of dura, exposed cortical bone, venous sinuses, internal carotid artery, and major nerves, all without cutaneous cover. A large posteriorly-based scalp flap was rotated over the defect by the plastic surgery team. The flap donor area on the frontal and vertex portions of the skull was covered with a split thickness skin graft. The wound healed per primam (Fig. 4 upper right and lower left). A postoperative skull film is shown in Fig. 4, lower right.

Final histological examination showed infiltration of the bone canal with basal cell carcinoma with no involvement medial to the tympanic membrane (Fig. 5). All lymph nodes removed with the specimen were negative.

Postoperative Course. There has been no evidence of tumor recurrence in the 4 years since operation. The patient has no neurological deficit except for a complete right seventh nerve paralysis. He has required a lateral tarsorrhaphy for treatment of paralytic ectropion. He is asymptomatic and has returned to work.

Case 2

On July 3, 1970, a 61-year-old man was admitted for treatment of bleeding from a skin cancer of the left ear of 5 years' duration. Fourteen months previously a doctor had told him that the lesion was too extensive to be removed and it had remained untreated (Fig. 6).

Examination. There was a 10 × 9 cm ulcerated neoplasm involving the anterior and superior portions of the left ear and extending into the squamous portion of the temporal bone and the zygomatic arch, with paralysis of the facial nerve except for its
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There were several 1 to 2 cm movable nodes in the digastric and upper jugular regions. Biopsy showed the lesion to be squamous cell carcinoma. There was no evidence of metastasis to the lungs or skeleton. Sagittal temporal bone tomograms showed bone erosion on the ear canal. A carotid arteriogram showed elevation of the anterior portion of the left middle cerebral artery. Nasopharyngoscopy, evaluation of Eustachian tube function, and facial and skull films were all normal.

Operation. On July 15, 1970, operation was first determined by a negative frozen section of the supraclavicular lymph nodes and exploration of the middle fossa through a subtemporal craniectomy, which showed no evidence of intradural extension. A left radical neck dissection, which included the

suboccipital nodes, was carried out plus a left superficial parotidectomy, osteotomy of the ascending ramus of the mandible and zygomatic arch, and division of the musculature of the infratemporal fossa to the skull base. An en bloc resection of the temporal bone was performed. It was also necessary to extend the resection anteriorly to include the major portion of the sphenoid ridge in order to obtain adequate margins about the involved dura. A plaque of tumor involving dura required wide dural excision and fascia lata graft (Fig. 7).

An anteriorly-based rotation scalp flap was used to cover the defect, and the donor site was covered with a split skin graft (Fig. 8 left). Vital structures remained well covered. All lymph nodes proved histologically negative. Scalp flap redundancy was trimmed, and a medial canthoplasty on the left eye was done for paralytic ectropion on December 9, 1970.

Postoperative Course. Two and one-half years following surgery the patient is clinically free of tumor; his wound has remained well healed (Fig. 8 right). His balance is intact and he has returned to his former occupation as a firewood cutter.

Discussion

The literature in past years has indicated a poor prognosis for patients undergoing temporal bone resection. The operative mortality has frequently exceeded the 5-year survival rate of 18% to 28%. This has resulted in a feeling of defeatism toward the operation by many physicians.

The more recent literature indicates the need for reappraisal in the light of improved survival rates and broadened indications for the operation. Temporal bone resection can result in a significant salvage of advanced cases of carcinoma of the external ear with secondary involvement of the temporal bone. Whereas previous reports dealt almost exclusively with tumors that were primary within the middle ear, Coleman and Hanna, et al., have dealt with carcinoma that secondarily involved the temporal bone from the external ear and parotid.

Middle ear cancer remains hidden for a long time and is often not discovered until it has broken its bounds and extended intracranially. Carcinoma which secondarily in-
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Fig. 7. Case 2. Upper: Operative photograph after temporal bone resection and neck dissection. Lower: Line drawing to clarify the following landmarks: sigmoid sinus (A), transverse sinus (B), remainder of temporal bone (C), sphenoid bone left in middle fossa (D), the trigeminal nerve, 3rd division (E), remainder of zygoma (F), temporal muscle (G), transverse process of C-2 vertebra (H), internal carotid artery (I), external carotid artery (J), internal jugular vein (K), hypoglossal nerve (L), semispinalis cervicis (M), suboccipital muscles (N), masseter muscle (O), pterygoid muscle (P), thyroid cartilage (Q), pharynx (R), hyoid bone (S), angle of mandible (T).
volves the temporal bone is usually discovered earlier when an adequate surgical margin is more easily obtained. Coleman, using an en bloc technique, reported a 37% cure rate after 5 years. Hanna, et al., used a technique of piecemeal removal with a rongeur and obtained a 42% 5-year cure rate while attaining a 0% operative mortality. Two of Hanna's cases were of primary middle ear cancer, and the remaining 10 were of tumors that secondarily involved the bone. The reduction of morbidity for this operation depends upon better exposure and familiarity of the surgeon with the techniques of intracranial dissection.

To perform an adequate resection without unnecessary sacrifice of the vital structures, it is recommended that a formal en bloc technique of resection be carried out whenever possible. In this procedure, exposure and protection of vital structures is secured first. Only then are the major bone transections performed. This approach also appears more in line with standard cancer technique than does piecemeal resection.

Complications are listed as operative and postoperative hemorrhage, cerebrovascular accident, postoperative brain abscess, and pneumonia. Seventh nerve palsy is an inevitable result. Vertigo lasts for a few weeks in some patients. Our one complication was transient vertigo which lasted for 3 weeks in the second patient.

There has been a vast discrepancy between the end results reported by radiotherapists using the same modality of technique. It should be pointed out that enthusiastic radiotherapy may result in osteoradionecrosis accompanied by intractable pain.

Neither of our patients was given x-ray therapy because it was felt that complete removal of the tumor had been accomplished.

Temporal bone resection is indicated when cancer of the ear is clinically adherent to bone as well as when there is x-ray evidence of bone involvement. Contraindications to temporal bone resection include extension of cancer through the Eustachian tube to the nasopharynx, to the medial skull base with involvement of multiple cranial nerves, to the cervical spine, to the carotid canal, or metastasis below the clavicle.

Preoperative Evaluation

To determine operability and to plan the extent of operation, the following procedures are recommended: 1) neurological examinations including hearing and vestibular tests; 2) skull and cervical spine films; 3) polytomography of the temporal bone; 4) nasopharyngoscopy; 5) brain scan; 6) carotid arteriography; and 7) jugular venography if invasion of the jugular vein and lateral sinus is suspected.
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Operative Evaluation

During operation, scalene node biopsy and exploration of the middle fossa are carried out. With tumors prone to wide lymphatic spread, preliminary scalene node biopsy will determine the peripheral extent of disease and ascertain the advisability of a radical attack on the primary tumor. We feel that involvement of the scalene nodes indicates advanced peripheral spread of the tumor beyond the chance of cure. Palliative therapy only is recommended in these cases. Through a subtemporal craniectomy approach, the extent of intracranial middle fossa involvement can be defined. Armed with this information early in the procedure, one may then plan and carry out the major resection with more assurance of adequate removal.

Tumor Origin

Brief mention should be made of the four most common tumors that secondarily involve the temporal bone: basal cell and squamous cell carcinoma, melanoma, and parotid tumors. Rules of thumb regarding adequacy of margins and evaluation of regional lymphadenectomy based on known pathophysiology apply here as elsewhere. In our first patient, the basal cell carcinoma was aggressive but localized. There was no involvement of the middle ear or lymph nodes by preoperative evaluation. These findings were confirmed at surgery by exploration of the middle fossa and by biopsy of the lymph nodes. A wide excision, totally inclusive of the tumor, was carried out. In our second patient there was a large squamous cell carcinoma which by preoperative evaluation had extended intracranially to involve the dura. The lymph nodes were clinically positive. Dural involvement was suggested by arteriography and confirmed by exploration. Neck dissection was done because of the character of the tumor. At operation the extent of the tumor was first determined by exploration of the temporal fossa. A wider excision was thus planned to excise this tumor completely.

Based on these two reports and our own experience, we believe that resection for secondary involvement of the temporal bone with carcinoma may be approached with an attitude of cautious optimism. Preoperative tests and preliminary operative procedures to determine operability must be carried out in order to establish the feasibility and the limits of resection.

Scalp Flap Coverage

Adequate skin cover must be provided if prolonged morbidity is to be prevented. This coverage must be readily available without the delay of prior surgical procedures. It must be durable and able to provide some protection to underlying structures. It must carry its own blood supply to cover avascular structures and grafts. Finally, it must be capable of being re-elevated in the event that a later exploration or placement of some rigid protection for the brain is desired. Free split thickness skin grafts fulfill only the first of these requirements. A large, undelayed rotation scalp flap with its donor site covered with split skin graft is most likely to fulfill all these requirements and to result in primary healing.

While the principles governing successful rotation scalp flap construction are common to all flaps in general, certain points deserve emphasis:

1. Although there is considerable cross-anastomosis of blood vessels in the scalp, for maximum safety the flap should be based on the periphery of the scalp rather than on the relatively avascular midline and include as many of the major terminal vessels as practical.

2. A pattern is cut to fit the defect and is used in marking out the flap. This "working backward" from the defect to the donor site assures a flap of adequate size. Marking a flap of generous size avoids compromise of blood supply by kinking and suturing a flap of inadequate size under tension.

3. A scalp flap will frequently develop necrosis distal to a traversing old scar. Such scars are best avoided, if possible, when planning the flap.

4. It is better to use a single large flap than two or more smaller flaps. In this way any minor complication of the suture line will not occur directly over
a vital structure, and a major problem may be avoided.

5. A flap adjacent to an irradiated field or one based on the midline requires preliminary surgical delay to improve its circulation. This is done by incising the proposed flap on three of its four sides 3 weeks before the definitive surgery.

6. Elevation in the subgaleal plane assures preservation of the blood supply which is located subdermally.

7. The periosteum in the donor area must be left intact to provide a vascular bed to accept either a primary or delayed-primary split thickness skin graft.

Flap Usage

In the first patient, a large direct rotation flap based posteriorly was used (Fig. 9 left). The blood supply arose from the occipital vessels and muscular branches of the vertebral arteries. The forehead end covered the defect and the defect skin was grafted. In the second patient, a larger defect resulted. It was felt that a safe, though larger, flap could be developed with its base anterior (Fig. 9 right). It was vascularized by both right and left supraorbital and frontal arteries and the opposite superficial temporal artery. Parietal, occipital, and nuchal skin was transferred in this manner.

The cosmetic defect produced by disturbance of the hairline is felt to be justified by the expediency of the repair. The scalp flap is easily available and in the same surgical field. Flaps from a distance require prior preparation and transfer in several stages. If it is later desired to restore the hairline, a distant flap may be prepared, the hair-bearing flap transferred back to its original place, and the distant flap brought in to cover the temporal defect.

Conclusions

The prognosis of cancer extending from the external ear to the temporal bone is far better than cancer arising from within the middle ear or mastoid. Although there have been some reports of cure by x-ray therapy of this type of lesion, post-radiation necrosis can be very painful and disabling. Subtotal en bloc temporal bone resection appears to be the treatment of choice for advanced cancer of the external ear, when the procedure is performed with strict attention to the principles of neurosurgery and plastic surgery.
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**References**


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