SURGICAL CONSIDERATIONS IN MAXILLECTOMY FOR ANTRAL MALIGNANT NEOPLASMS

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ABSTRACT

This paper highlights the salient principles which should guide the surgeon in selecting the type of maxillectomy for the management of malignant neoplasms of the maxillary antrum; The problems of accurate clinical evaluation of local spread of this insiduous disease were also discussed. A rational approach to maxillectomy including craniofacial resection was proposed. It is concluded that surgeons must endeavour to adhere to the principle of 'en-bloc' resection in this anatomically complex area if the treatment outcomes of this awesome disease is to improve in the coming decades.

KEY WORDS: *Maxillectomy, Craniofacial Resection, Antral Malignant Neoplasms.*

INTRODUCTION

Though antral malignant neoplasms are relatively uncommon (0.1 - 0.4 per cent of all cancers), the surgical management is complex and challenging[1,2,3]. This is mainly because the disease is insiduous and patients usually present with advanced local spread[3]. Furthermore effective clinical and radiological evaluation of the extent of local spread is difficult resulting in inaccuracies in preoperative clinical staging of the disease[3,4,5]. Therefore, the results of treatment for this disease has been poor relative to other head and neck malignancies. It has even been submitted that these results are not different from those reported three decades ago[3]. There is little doubt that this disease which has been reported to constitute 28.7% of orofacial cancers in Nigerians is of great interest to Oral and Maxillofacial Surgeons practicing in our environment[5]. The inability of the surgeon to completely remove the tumour is responsible for the high rate of treatment failures[6,7,8]. This paper will discuss the different types of maxillectomy that may be indicated for the management of antral malignant neoplasms. It is our hope that this will serve as a guide to surgeons, trainee surgeons and will contribute to improved treatment outcome in the decades ahead.

OBJECTIVES OF SURGERY

Cancer of the maxillary antrum is often characterised by an insiduous onset, a protracted clinical course and resistance to most forms of therapy. This generally poor result has been attributed to the advanced stage of the disease at diagnosis, the complex anatomy of the area and the reluctance of surgeons to employ radical surgery which may result in mutilation, morbidity and dysfunction[9,10]. The primary aim of surgery is wide ('en-bloc') resection of the tumour. As in all oncological operations, the first operation is the best and often the last opportunity to cure the

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disease[11,12]. The surgeons responsibility is to clear the tumour with a reasonably wide margin and by the most appropriate means, even if the patient has received previous radiotherapy. The classical maxillectomy is rarely indicated, being suitable only when the disease is confined within the bony walls of the antrum. More frequently, this operation must be extended to include orbital contents, ethmoid, malar bones or base of skull in the resection[11,12].

CLINICAL EVALUATION AND STAGING.

One of the major challenges in the surgical management of antral malignancies is the evaluation of the extent of the disease[13]. This is of considerable significance because the extent of the disease should determine the extent of surgical resection. Clinical preoperative evaluation entails inspection and palpation of the face, oral cavity and the nose. Occipitomental radiographs, tomograms, base of skull views, computerized tomographic scan (CT Scan) and magnetic resonance imaging (MRI) are also valuable in assessing the extent of the disease[14,15,16,17]. CT scan and MRI tend to complement each other, but MRI is preferred because of its ability to distinguish retained mucus from soft-tissue tumour mass in addition to detecting bony invasion and intracranial extension. There is little doubt that availability of these two diagnostic modalities have greatly improved staging of the disease, patient selection and operative planning[18]. Endoscopic sinus surgery may be necessary for assessment of tumour invasion of the sphenoid sinus[19]. Ophthalmologic consultation to determine the extent of eye involvement may also be indicated. Intraoperatively, careful inspection and palpation of the oropharynx is useful in assessing posterior extension of the disease. It should be mandatory for patients to give permission for the eye to be removed if it is found to be involved intraoperatively[11,20].

From a surgeons point of view, the complex anatomy of the antrum and its adjacent structures have traditionally been

classified into three groups:

a) Structures amenable to en-bloc resection (nasal septum, nasal cavity, palate and skin of cheek).

b) Structures that may defy uniform en-block resection (ethmoid sinus, sphenoid sinus, cribriform plate, posterior maxilla, pterygoid plate, posterior orbit, infratemporal fossa).

c) Structures not amenable to control by maxillectomy (base of skull, vault of nasopharynx).

There have been many proposals for clinical staging of the disease; a reflection of the difficulty of accurately determining the extent of the neoplasm[21, 22, 23, 24, 25]. Three of these however merit further discussion.

Ohngren's Classification

In 1933 Ohngren[26] divided the facial skeleton as seen in profile into postero-superior and antero-inferior parts using a line drawn from the inner canthus to the mandibular angle. He observed that tumours situated postero-superior to this plane had worse prognosis than those situated antero-inferiorly. This observation is still widely regarded as true even today and is the basis of the Union Internationale Contre le Cancer (UICC) and The American Joint Committee on Cancer Staging (AJCC) classifications[27].

American Joint Committee on Cancer Staging (AJCC).

In 1983, AJCC proposed the following classification for maxillary sinus cancers[27]:

Stage I Tumour confined to the infrastructure with no evidence of bone involvement.

Staqe II: Tumour of the suprastructure with no bone involvement, or tumour of infrastructure with involvement of bone of medial or inferior walls.

Stage III: Tumour invading orbit, anterior ethmoid region, pterygoid muscle, or skin of cheek or single homolateral lymph node metastasis of 3cm or less in diameter.

Stage IV: Tumour invading cribriform plate, posterior ethmoid region, sphenoid sinus, nasopharynx, pterygoid plates, base of skull or single lymph node metastasis.

Calearo et al's Classification (Fig. 1)

Calearo et al in 1987[28] pointed out that the major defect of the AJCC classification is that it is limited only to tumours arising in the maxillary antrum. They submitted that since the nasal cavity and the paranasal sinuses are a functional unit, a uniform clinical staging is indicated for cancer arising from this anatomic and functional unit. They therefore proposed the following classification.

T1: Contained in one site without bone involvement

T2: Contained in one site with bone involvement

T3: Involvement of two or more sites but still limited to one region.

T4: Involvement of adjacent regions**

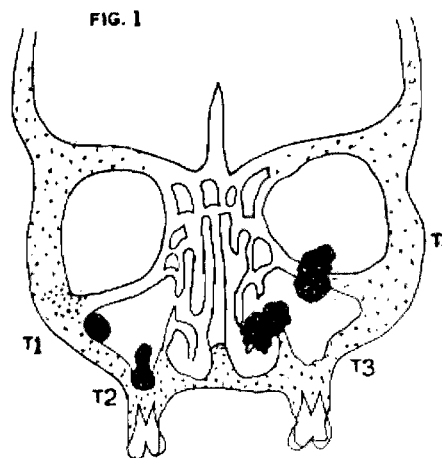* Sites = nasal cavity, maxillary sinus, ethmoid, frontal sinus, sphenoid sinus.

Fig. 1. **Calearo et al's Classification**

Fig. 2. **Late presentation of antral malignant neoplasm**

** Adjacent regions = 1. Oral cavity, 2. soft cheek tissues, 3. Pterygomaxillary fossa, rhinopharynx, 4. Orbit, neurocranium.

Carinci et al[29] have further proposed a differential analyisis of T4 tumours depending on the adjacent region involved.

MAXILLECTOMY.

The resection of the maxilla and continguous structures for cancer can be classified into four [20, 29, 30], namely;

i. Limited resection of the maxilla (partial maxillectomy).

ii. Maxillary resection including the floor of the orbit with preservation of the globe (total maxillectomy).

iii. Radical resection of the maxilla with orbital and ethmoid exenteration (total maxillectomy with orbital exenteration).

vi Craniofacial resection (total maxillectomy with anterior skull base resection and orbital exenteration as indicated).

i. Limited Resection of the Maxilla.

In this procedure, the globe and orbital floor are left intact and the ethmoidal labyrinth is removed by curettage. This is

indicated in malignancies involving only the floor of the antrum. The procedure can be briefly discussed under three subheadings.

a) Incision and flap development. The skin incision starts from the lip to nasal aperture to nasolabial sulcus to nasal bridge to inner canthus to beneath the eyelashes to outer canthus. The intraoral incision runs from the buccal sulcus to the tuberosity to join the palatal incision.

b) b) Separation of bony attachments: Mallet and chisel and Gigli saw could be used to separate the maxilla from its adjacent bony attachments at the following sites:

i. Hard palate
ii. Nasal process of maxilla (about 1.0 -1.5cm from the infraorbital rim).
iii. The upper third of the maxilla. iv. Body of zygoma
v. Pterygomaxillary attachment. vi. The superior and middle turbinates.

c. **Tumour Delivery:** The mobilized specimen, is held with a bone holding forceps and the mass delivered with a gentle rocking movement of the maxilla. Branches of the internal maxillary artery in the pterygo-maxillary fissure are ligated and the anterior and posterior ethmoids curetted. The defect is either covered with a split thickness skin graft, a suffratulle gauze, or presurgically prepared obturator prosthesis.

Undoubtedly, this is the most common type of maxillectomy performed for antral malignancies in most centers
in Nigeria. However, it is grossly inadequate; being only suitable for tumours of the palate or antral cancers involving only the floor.

ii. Maxillary Resection Including the Floor of the Orbit With Preservation of the Globe.

This procedure is indicated when there is no radiologic evidence of erosion of orbital floor, but the tumour virtually fills the antrum. The major differences between this and the limited resection include:

i. The first step in the operative procedure is surgical exploration of the floor of the orbit via an infraobital rim incision. This is to confirm that the floor of the orbit has not been eroded.
ii. Transection of the frontal process and arch of the zygoma by a Gigli saw.
iii. The medial attachment of infraorbital rim is transected just inferior to the medial canthal ligament.
iv. Transection of the orbital floor.
v. Mobilization of the temporal muscle flap to support the globe.

iii. Radical Resection of the Maxilla With Orbital and Ethmoid Exenteration.

This is the ideal operative procedure for most malignant tumours of the maxillary antrum. The rationale for selecting this procedure is the intimate and complex relationship of the antrum to the ethmoidal and sphenoidal sinuses as well as the orbital contents. The indications for orbital exenteration are involvement of the bone of the roof of the antrum, invasion into the orbit and significant infiltration of the ethmoidal labyrinth. The major highlights of this procedure include:

i. Avoidance of entry into the antrum.
i. Resection of the orbital contents with the roof of the antrum,
ii. Most of the ethmoid should be resected en-bloc, leaving the orbital defect open for regular inspection in order to detect recurrences early.
iv. Preservation of the soft palate.

The incisions and flap development are similar to that of the limited resection of the maxilla. (Trotter-Weber-Ferguson Incision). The major differences are in the separation of bony attachments at the following points.

i. Nasal process of maxilla.
ii. Zygomatic arch
iii. Lateral orbital rim.
iv. Maxilla from frontal bone
v. Postero-lateral attachment of the maxilla.
vi. Medial aspect of the orbit.

Tumour delivery follows the same steps previously enumerated for limited resection.

iv. Craniofacial Resection.

Smith et al in 1954[31] reported the first combined transcranial and transfacial resection of a paranasal sinus tumour. This procedure is indicated in relatively advanced antral cancer with extension into the ethmoid area and antro-ethmoidal lesions involving the cribriform plate which were previously treated palliatively. Infact tumours involving this area were previously considered technically unapproachable by surgical and radiotherapeutic means. The underlying principles of this procedure involve the application of the principle of *en-bloc* resection together with mandatory antibiotic prophylaxis neurosurgical assistance, subarachnoid decompression, selective preservation of orbital contents, and rapid restoration of facial contour[30,31,32,33]. The cranial surgery provides additional exposure that allows the application of the principle of en-bloc resection. The important steps in the surgical procedure include[30,31,32,.33].

a) Frontal Craniotomy.

A subarachnoid catheter for cerebrospinial fluid decompression is placed before the craniotomy. The craniotomy 'is essentially an enlarged bore hole in the frontal bone via a transverse skin incision at the midline of the forehead skin. The frontal lobe is retracted upwards for inspection of the floor of the anterior cranial fossa and cribriform plate area. Any dura adhesion will necessitate dura excision and immediate repair with fascia lata or temporalis fascia. The chief objective of frontal craniotomy is to determine the cranial extent of the tumour in order to decide if it is resectable. Contraindications to further surgery include:

i) Extension of the tumour through the dura into the frontal lobes.
ii) Posterior extension beyond the cribriform plate.
iii) Involvement of the optic nerves and
iv) Lateral extension outside the boundaries of the fovea ethmoidalis and into the region of the superior ethmoidal fissure.

b) Facial Approach.

This is essentially via a modified Weber-Fergusson incision; the lip may not be split. The objective is surgical exposure of the anterior wall of the maxilla and the floor of the orbit in order to evaluate the boundaries of the tumour. A complete lateral rhinotomy is made with an antero-superior division of the nasal septum. The nose is displaced to the opposite side and both nasal cavities exposed. The cartilage of the nasal septum is usually removed for effective evaluation of tumour boundaries. Bone is removed from the walls of the nasal aperture for better exposure of the nasal cavity.

The periosteum is elevated from the medial and inferior walls of the orbit and if there is no tumour encountered, orbital exenteration may not be necessary. However, the orbital floor must be resected and temporalis fascia used to support orbital contents. Great care should be observed in the region of the posterior orbital wall and the postero-medial orbital walls because of the adjacent middle cranial fossa where there are major structures (internal carotid artery and cavernous sinus) which do not tolerate surgical intervention. Antrostomy is performed in the canine fosssa to inspect the maxillary sinus. If the sinus floor is not involved, the hard palate may be preserved.

c). Ostectomy and Tumour Delivery.

After the boundaries of the tumour has been assessed, bone cutting instruments are used to release the tumour and a cuff of normal tissues from its attachments. The placement of any of these bone cuts varies with the extent of the neoplasm. Essentially, a partial or total maxillectomy with or without orbital exenteration is performed in addition to removal of the ethmoid complex.

Osteotomes are used to mobilize both sides of the cribriform plate and fovea ethmoidalis. Cuts along the lateral aspect of the roof of the ethmoid are matched with those in the fronto-ethmoidal suture made during the facial approach. The ethmoid complex on the side opposite the tumour is also removed. The posterior wall of the frontal sinus is included in the resection and if necessary, the anterior portion of the roof of the sphenoid sinus is removed.

After the tumour is mobilized, it is grasped inferiorly while pressure is exerted through the cranial defect on the cribriform plate. The remaining attachments are cut and the tumour is delivered through the facial defect. Haemostasis is achieved by ligation of the terminal branches of the internal maxillary artery, electrocautery, bone wax and pressure packing. The cribriform (Cranionasal) defect is repaired in three layers:

i)   Dura tears and defects can be repaired with direct suturing and fascia lata;
ii) iliac crest or septal cartilage can be used to prevent herniation of anterior cranial contents into the nasal fossa;
iii) Split thickness skin graft which is part of the lining of the maxillectomy defect.

Complications associated with this procedure include cerebrospinal fluid leakage, delayed haemorrhage, subdural abscess, meningitis, otitis media and diplopia[32,33,35]. Ketchman and Van Buren[30] in 1985 reported 43.8 per cent survival (4-24 years) and a 3 per cent hospital mortality in a group of 89 patients whose previous surgery or radiotherapy was largely unsuccessful. However, Kaye et al[34] in their series of 83 patients, reported no mortality, only one facial infection and a 5year survival of 80%. Their low infection and Cerebrospinal fluid (CSF) leakage rate was attributed to meticulous closure of the dura and the use of a viable pericranial flap which is sutured around the edges of the bone defect in the anterior cranial fossa to exclude the cranial contents from the paranasal sinus. They advocated that this procedure should be used only when the aim of surgery is curative; for in palliative resection, excellent debulking of the tumour can be achieved through either a cranial or facial incision without the potential risks of a formal craniofacial resection. Similarly, Rutter et al,[35] reported a 5-year survival rate of 84% and a steep learning curve associated with the procedure (decrease in complication rate with more experience).

CONCLUSION

The extent of surgical resection planned for individual patients should ideally be based on the extension of cancer into adjacent structures as determined by radiological investigations preoperatively; and by intraoperative evaluation of surgical margins. In centers with computerized tomographic scan which is reformatted into 3- dimensional images, the type of maxillectomy can be preoperatively selected with a high degree of accuracy. However, in the absence of such facilities, the involvement of adjacent structures can only be ascertained intraoperatively. The onus is on the surgeon to ensure as far as possible 'en-bloc' resection; for as Ketchman and Van Buren[30] submitted, "cancer cannot be cured by removing it in pieces, with or without negative tumour margins, and expecting radiotherapy to 'sterilize' the tumour cell contaminated surgical field". The Maxillofacial or Ear, Nose and Throat Surgeon operating on a patient with this formidable disease must bear this in mind at all times. Collaboration with neurosurgery for craniofacial resection is highly desirable since many of our patients present with advanced local disease (Fig. 11) and are relatively younger at presentation than reported in Western literature[5].

REFERENCES

1.   **Jesse RH.** Preoperative versus postoperative radiation in the treatment of squamous cell. Carcinoma of the Paranasal Sinsuses. Am. J. Surg. 1965; 110: 552–556.

2.   **Batsakis JG.** Tumours of the Head and Neck. Baltimore, Williams and Wilkins Co. 1975. 177.

3.   **Har-EI G, Hadar T, Krespi YP, Abraham A, Sidi J.** Clinical experiences with Carcinoma of the Maxillary Sinus Ear, Nose and Throat Journal 1988; 67: 494–510.

4.   **Jesse RH, Bultler JJ, Healey, Jr. JE, Fletcher GH, Chau PM.** Paranasal sinuses and Nasal Cavity. In: MacComb WS, Fletcher GH eds. Cancer of the Head and Neck. Baltimore, Williams and Wilkins Co. 1967, 429–356.

5.   **Arotiba GT.** Malignant neoplasms of the maxillary antrum in Nigerians. West Afric. J. Med. 1998; 17(3): 173–178.

6.   Lee F. Ogura JH. Maxillary sinus carcinoma. Laryngoscope 1981; 91: 133–139.

7.   Bennet M. Symposium. Treatment of Malignancies of Paranasal sinuses. II. Paranasal sinus malignancies. Laryngoscope 1970; 933–943.

8.   Harrison DFN. The management of malignant tumours of the nasal sinuses. Otol. Clin. N. America. 1971; 4: 159–177.

9.   Frazell EL, Lewis JS. Cancer of the nasal cavity and accessory sinuses. CANCER 1963; 16(10): 1293–1301.

10. Kurohara SS, Webster JH, Ellis F, Fitzgerald JP, Shedd DP, Dadib OA. Role of radiation therapy and of surgery in the management of localised epidermoid carcinoma of the maxillary sinus. Am. J. Roentgenol. Radium Ther Nucl Med 1972; 114(1): 35–42.

11. Harrison DFN. The management of tumours affecting the maxillary and ethmoidal sinuses. J. Laryngol Otol. 1973; 87: 849–872.

12. Birt BD, Briant TDR. The management of malignant tumours of the maxillary sinus. In: Noyek AM, Zismor J. Eds. The Maxillary Sinus. Otorlaryngologic Clinics of North America 1976; 9(1): 249–267.

13. Harrisson DFN. Problems in he surgical management of neoplasms arising in the paranasal sinuses. J. Laryngol Otol 1976; 90(1): 49–58

14. Forbes WSTC, Fawcitt RA, Isherwood I, Webb R, Ferrington T. Computed tomography in the diagnosis of diseases of the paranasal sinuses. Clin Radiol. 1978; 29: 501–511.

15. Shramek JM, Rappaport I. Panoramic X-ray screening for early detection of maxillary sinus malignancy. Arch. Otorlaryngol. 1969; 90: 347–351.

16. Ohba T, Katayama H. Panoramic roentgen anatomy of the maxillary sinus. Oral Surg. 1975; 39(4): 658–664.

17. Gallagher TM, Boyles R. Symposium. Treatment of malignancies of paranasal sinuses and Carcinoma of the maxillary antrum. Laryngoscope 1970; 80: 924–932.

18. Chong VFH, Fan YF: Skull base lesion in nasopharyngeal carcinoma. Detection by CT and MRI Clin. Radiol. 1996; 51: 625–631.

19. Lund VJ, Howard DJ Lloyd GAS, Cheesman AD. Magnetic resonance imaging for paranasal sinus tumours for craniofacial resection Head Neck 1989; 11: 279–283.

20. Lore Jr. JM. Partial and Radical Maxillectomy In: Noyek AM, Zismor J Eds. The Maxillary Sinus. Otorlaryngol Clin North Amer 1976; 9(1): 255-267.

21. Dodd GD, Collins LC, Egan RL, Herrera JR. The systematic use of tomography in the diagnosis of carcinoma of the paranasal sinuses Radiology 1959; 72: 379.

22. Clifford P. Malignant disease of the nose and nasal sinuses in East Africa Brit J Surg. 1960; 48: 15–25.

23. Sisson GA, Johnson NE, Amiri CS. Cancer of the maxillary sinus: Clinical classification and management Ann. Otol Rhin Laryngol\ 1963; 72: 1050–1059.

24. Lederman M. Tumours of the upper jaw. Natural history and treatment J Laryngol Otol 1970; 83: 369–401.

25. Shibuya H, Suzuki S, Horiouchi J et al. Reappraisal of trimodal combination therapy for maxillary sinus carcinoma CANCER 1982; 50(12): 2790–2794.

26. Ohngren LG. Malignant tumours of maxillo-ethmoidal region. Clinical study with special reference to treatment with electrocautery and irradiation Acta Otorlayngol 1975; 19 (Suppl). 1476.

27. Del regato JA, Spjut HJ, Cox JD. Cancer Diagnosis, Treatment and Prognosis The CV Mosby Co. St Louis, Toronto, Princeton 1985, p.239.

28. Calearo C, Pastore A. Merlo R II. Cancro del massiccio facciale Acta Otorinol Ital. 1987; (Suppl). 1–27.

29. Carinci F. Curioni C, Padula E, Calearo C. Cancer of the nasal cavity and paranasal sinuses. A new staging stem Int. J. Oral Maxillfac Surg. 1996; 25: 34–39.

30. Ketchmann AS, Van Buren JM. Tumours of the paranasal sinuses. A therapeutic challenge. Am. J. Surg., 1985; 150: 406-413.

31. Jackson IT, Callan PP, Forte RA. An anatomic classification of maxillary ameloblastoma as an aid to surgical treatment J CranioMaxillofac Surg. 1996; 24: 230-236.

32. Smith RR, Klopp CT, Williams JM. Surgical treatment of cancer of the frontal sinus and adjacent areas. CANCER 1954; 7: 991–994

33. Sisson GA, Bytell DE, Becker SP, Ruge D. Carcinoma of the Paranasal sinuses and cranio-facial resection J Laryngol Otol 1976; 90(1): 59–68.

34. Kaye AH, Sizeland A, Briggs R, Kleid S, Costello B. Craniofacial resection for anterior skull base tumours. Comment Aust. NZJ Surg. 1999; 69: 235–236

35. Rutter, MJ, Furneaux CE, Morton RP. Craniofacial resection of anterior skull base tumours. Factors contributing to success Aust. NZJ Surg 1999; 68: 350–353.