A MODIFIED CLASSIFICATION FOR THE MAXILLECTOMY DEFECT

James S. Brown, MD, FRCS, FDS,1 Simon N. Rogers, FRCS, FDS,1 Deborah N. McNally, BSc (Hons),2 Mark Boyle, FRCS, FDS1

1 Regional Centre for Maxillofacial Surgery, University Hospital Aintree, Longmoor Lane, Liverpool L7 4AL UK. E-mail: brownjs@globalnet.co.uk
2 University of Liverpool, Department of Clinical Psychology, Brownlow Hill, Liverpool L69 3GB

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Abstract: Background. At present no widely accepted classification exists for the maxillectomy defect suitable for surgeons and prosthodontists. An acceptable classification that describes the defect and indicates the likely functional and aesthetic outcome is needed.

Methods. The classification is made on the basis of the assessment of 45 consecutive maxillectomy patients derived prospectively from the database (September 1992) and retrospectively from 1989.

Results. The classification of the vertical component is as follows: Class 1, maxillectomy without an oro-antral fistula; Class 2, low maxillectomy (not including orbital floor or contents); Class 3, high maxillectomy (involving orbital contents); and Class 4, radical maxillectomy (includes orbital exenteration); Classes 2 to 4 are qualified by adding the letter a, b, or c. The horizontal or palatal component is classified as follows: a, unilateral alveolar maxillectomy; b, bilateral alveolar maxillectomy; and c, total alveolar maxillary resection.


Keywords: maxillectomy; classification; reconstruction; obturation; rehabilitation

The term “maxillectomy” is widely used in head and neck surgery but often without qualification. This is one of the few defects created in the treatment of head and neck cancer that may result in both facial disfigurement and compromised oral function. A limited maxillectomy involving the posterior alveolus unilaterally can be effectively obturated and may cause the patient little functional or cosmetic embarrassment. A maxillectomy associated with exenteration of the orbit will result in a major cosmetic change for the patient and potential difficulties with obturation. If the posterior edge of the soft palate is included in a maxillectomy defect, the functional consequences become the main concern for the clinician and the patient. In each of these defects the effects on the patient and the approach to the reconstruction and rehabilitation are widely different. The need exists for a classification of this defect that takes into account the aesthetic and functional outcome and indicates the most appropriate form of management in terms of obturation or reconstruction.

Classification of the maxillectomy defect has been attempted both from the surgeon’s view and that of the prosthodontist.1–4 The group at The
Sloan Kettering Memorial Hospital have suggested what seems a simple classification but conclude, “the surgeon should indicate whether the maxillectomy has been extended to include adjacent structures.” Included as a low maxillectomy are cases in which the orbital floor and peri-orbita may have been resected. This will imply considerably more risk to the appearance and function of the eye than a resection that has left the orbital floor intact. MacGregor and MacGregor have suggested a classification that depends on the vertical component of the defect, but neither of these address the issue more pertinent to the prosthodontist, of the bilateral defect involving the nasal septum or the contralateral dental-bearing part of the maxilla or antral wall.

Obturation has been the traditional method of rehabilitation for the maxillectomy patient, but in recent years the wide variety of reconstructive options that are now available is challenging the traditional view. The need to examine the maxillectomy defect to detect early recurrence has to be considered against the considerable functional and aesthetic advantages of reconstructive surgery. The availability of endoscopic techniques and computerized imaging systems can be used to detect recurrent disease in reconstructed cases, and there is no evidence that a patient’s survival may be compromised by filing the defect. Local flaps can be useful for small defects, and the temporalis flap with vascularized cranial bone can provide sufficient bone for implants. Free tissue transfer techniques make it possible to close large alveolectomy defects and provide sufficient bone for an implant-retained prosthesis. Therefore, a need exists to classify the maxillectomy defect so that the results of obturation and reconstruction can be compared between units and across the world literature. This is especially important as functional and quality of life outcomes are becoming as important as cure rates in the assessment of the outcome in head and neck cancer.

The classification suggested in this article is designed to predict both the functional and aesthetic outcome likely to result from this surgery and relate that to the method of obturation or reconstruction suitable for each maxillectomy defect.

METHODS

Forty-five Maxillectomy Cases. Of a total of 487 patients entered onto the database for head and neck malignancy (mucosal and salivary gland) between September 1992–August 1997, 52 patients underwent resection of part of the maxilla. A proportion of this group (19 of 52) had small posterior maxillectomies as part of wider oral cavity resections for tumors arising in the buccal mucosa, soft palate, and retromolar region. The method of reconstruction for this patient group (19 patients) did not relate to the extent of the maxillectomy defect, which was classified as Class 1 (Figure 1) in 16 patients, with only 3 patients’ resections resulting in a low oro-antral fistula (Class 2a). The method of reconstruction related to the mandibular defect, and therefore these patients were excluded from the maxillectomy analysis. The remaining 33 patients had tumors arising in the palate, alveolus, and antrum requiring a maxillectomy, which was the main defect as far as rehabilitation was concerned (Table 1). In addition to this sample of 33 patients prospectively entered onto the database, it was possible to include a retrospective group of 12 patients from 1989, who had sufficient records for an accurate assessment of the size of the defect and the method of rehabilitation.

Two pilot classifications, which included the extent of the soft palate resection and the location of the palatal defect (anterior or posterior), were tested with this group of 45 patients before deciding on the suggested classification in this article. Of the initial group of 45 maxillectomy patients 30 were available to complete the University of Washington (UoW) questionnaire. This is a 9-point questionnaire completed by the patient without assistance, which has global quality of life measures and head and neck–specific questions. Each of the questions is scored from 1–100, with a score of 100 indicating an optimum outcome. These scores can then be averaged for the group concerned and comparisons made. The functional and quality of life outcomes for smaller maxillectomy defects (Class 1 and 2a) were compared with the larger defects (Class 2b plus).

RESULTS

Classification for the Maxillectomy Defect. The surgical defect is classified according to the vertical dimension of the maxillectomy (Class 1–4), which relates to the involvement of the orbit and skull base and the resultant mainly aesthetic deformity (Figure 1). Class 2–4 is qualified by the extent of the soft palate resection and the location of the palatal defect (anterior or posterior), were tested with this group of 45 patients before deciding on the suggested classification in this article. Of the initial group of 45 maxillectomy patients 30 were available to complete the University of Washington (UoW) questionnaire. This is a 9-point questionnaire completed by the patient without assistance, which has global quality of life measures and head and neck–specific questions. Each of the questions is scored from 1–100, with a score of 100 indicating an optimum outcome. These scores can then be averaged for the group concerned and comparisons made. The functional and quality of life outcomes for smaller maxillectomy defects (Class 1 and 2a) were compared with the larger defects (Class 2b plus).
horizontal or palatal component of the defect more closely relates to the likely functional and dental outcome for these patients.

**Vertical Component.**

Class 1 Maxillectomy with no oro-antral fistula
Class 2 Low maxillectomy
Class 3 High maxillectomy
Class 4 Radical maxillectomy

**Horizontal Component.**

a Unilateral alveolar maxilla and hard palate resected. Less than or equal to half the alveolar and hard palate resection not involving the nasal septum or crossing the midline
b Bilateral alveolar maxilla and hard palate resected. Includes a smaller resection that crosses the midline of the alveolar bone including the nasal septum
c The removal of the entire alveolar maxilla and hard palate

**Explanation of terms**

Class 1 The removal of alveolar bone not resulting in an oro-nasal or oro-antral fistula. Resections of the ethmoid and frontal sinus cavity defects or removal of the lateral nasal wall would fit into this part of the classification. Included in this group is the removal of only palatal bone, which will inevitably result in an

**Table 1. Site of tumors.**

<table>
<thead>
<tr>
<th>Site</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction of hard and soft palate</td>
<td>7</td>
</tr>
<tr>
<td>Hard palate</td>
<td>5</td>
</tr>
<tr>
<td>Tuberosity</td>
<td>4</td>
</tr>
<tr>
<td>Alveolus</td>
<td>12</td>
</tr>
<tr>
<td>Antrum</td>
<td>16</td>
</tr>
<tr>
<td>Nasal</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
</tr>
<tr>
<td>Buccal*</td>
<td>7</td>
</tr>
<tr>
<td>Retromolar*</td>
<td>9</td>
</tr>
<tr>
<td>Soft palate*</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
</tr>
</tbody>
</table>

*Excluded from the analysis.
oro-nasal fistula but leaves the dental-bearing part of the maxilla intact.

Class 2 The alveolus and antral walls but not including the orbital floor or rim.

Class 3 Including the floor of the orbit with or without peri-orbita and with or without skull base resection.

Class 4 Plus orbital exenteration with or without anterior skull base resection.

For example, a radical maxillectomy (including orbital exenteration) that includes less than half of the maxillary alveolus would be classified as a Class 4a.

In general the Class of the defect (1–4) indicates the likely aesthetic effect of the surgery and the qualifying letter (a, b, or c) the increasing difficulty of full oral and dental rehabilitation, which indicates the functioning dental outcome. The relationship of this classification to the rehabilitation options is illustrated in Figure 1. A local or pedicle flap (eg, temporalis) functions well in Class 1 and Class 2a but becomes less reliable as the horizontal component extends across the midline (Class 2b). Although an obturator is possible for any defect, its use becomes problematic in more extensive palatal and dental defects (Class b, c) or resections that include the orbit (Class 4). Similarly soft tissue free tissue transfer will result in less reliable dental rehabilitation in larger defects, in which bone that can be implanted would be an advantage. The lines in the figure indicate the usefulness of each choice of reconstruction as they relate to the defect.

This principle is confirmed in the analysis of the methods of reconstruction as they relate to the classification of the surgical defect (Table 2). Important differences exist in the choice of rehabilitation, depending on the class of the defect. Obturation has been used in 44% of the Class 2a defects but much less frequently as the size of the defect increases. Although few cases were treated with obturation in the larger defects, the problems of successful obturation will mount as the vertical and horizontal components of the resection increase (Figure 2). Composite grafts were infrequently used for Class 1 and 2a cases (4 of 24, 17%), compared with 15 of 21 cases (71%) of Class 2b and above.

Of these 45 patients with tumors arising in the maxillary alveolus, palate, and antrum, only 3 patients had the posterior part of the soft palate included in the resection. Two of these patients had tumors arising in the tuberosity of the maxilla. The other patient had an extensive adenoid cystic carcinoma excised from the antrum and extending into the soft palate tissues. In the tuberosity cases little need exists to reconstruct the maxillary bone because the lesions are posterior, leaving sufficient anterior and contralateral maxilla to support a tissue-borne or implant-retained denture. All 3 patients had reconstruction with a radial forearm flap, which reflects the need to reconstruct the soft palate.

The average totals from the UoW questionnaire, comparing Class 1 and 2a defects (16 cases) with larger resections (Class 2b plus, 14 cases), are presented in Table 3. This table presents the individual data for the average results in each of the UoW domains and the cumulative scores in each group. The results indicate the usefulness of this form of classification, with the larger defects (Class 2b plus) having a significantly lower cumu-

**Table 2. Tumors arising in the maxillary alveolus, tuberosity, palate, junction of hard and soft palate, or antrum (46 cases)**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Obturate</th>
<th>Radial</th>
<th>CR</th>
<th>DCIA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>1</td>
<td>7</td>
<td>—</td>
<td>—</td>
<td>8</td>
</tr>
<tr>
<td>Class 2a</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Class 2b</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Class 2c</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Class 3a</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Class 3b</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Class 4a</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Class 4b</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>11</td>
<td>14</td>
<td>8</td>
<td>12</td>
<td>45</td>
</tr>
</tbody>
</table>

Abbreviations: CR, composite radial forearm flap; DCIA, vascularized iliac crest graft with internal oblique muscle.
relative score ($p = .02$). In addition, the lower scores for activity and recreation in the larger maxillectomy defects were highly significant.

**DISCUSSION**

**Class 1.** The removal of maxillary bone without the creation of an oro-nasal or antral fistula can only be carried out on patients with a sufficient height of alveolus. Simple methods of reconstruction may be used, but obturation of the defect is generally not required. This form of defect mainly occurred in the tuberosity region of the maxilla for patients undergoing surgery for tumors arising in the soft palate or the retromolar trigone. Also denoted as Class 1 are defects that occur in only the palatal, nonalveolar bone of the maxilla, resulting in a central oro-nasal fistula. This defect can be closed with soft tissue alone because the dental-bearing bone of the maxilla remains unresected. A central palatal defect can also be successfully obturated in a dentate maxilla (Figure 4). Obturation can also successfully rehabilitate an edentulous case, but retention of the denture can be troublesome. If a flap reconstruction is chosen to close the defect, the height of the antrum does not require reconstruction, allowing a wide choice of local, pedicle, and free flaps. Full-thickness cranial bone can be brought into the oral cavity and vascularized on the temporalis or galeo-pericranial flaps. Free scapula, fibula, and composite radial forearm flaps provide sufficient height to replace the bone in this situation. If an implant-retained prosthesis is planned, consideration must be given to the quality of bone in the residual maxilla and the choice of composite reconstruction. In this series of patients, a variety of rehabilitation techniques have been used, indicating the wide choice available to the clinician in this class of defect (Table 2). In more extensive alveolar defects (b, c) or in edentulous cases, obturation will be more difficult to achieve (Figure 2). In this situation the same methods of reconstruction as in Class 2a would be adequate to restore form and function as long as sufficient bone was made available for implants to be placed in a

<table>
<thead>
<tr>
<th>Classification</th>
<th>Class 1 and 2a (16 cases)</th>
<th>Class 2b plus (14 cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Washington</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Pain</td>
<td>80</td>
<td>25</td>
</tr>
<tr>
<td>Activity*</td>
<td>77</td>
<td>19</td>
</tr>
<tr>
<td>Recreation†</td>
<td>88</td>
<td>13</td>
</tr>
<tr>
<td>Employment</td>
<td>49</td>
<td>29</td>
</tr>
<tr>
<td>Disfigurement</td>
<td>73</td>
<td>23</td>
</tr>
<tr>
<td>Speech</td>
<td>83</td>
<td>15</td>
</tr>
<tr>
<td>Chewing</td>
<td>63</td>
<td>22</td>
</tr>
<tr>
<td>Swallowing</td>
<td>86</td>
<td>15</td>
</tr>
<tr>
<td>Shoulder function</td>
<td>96</td>
<td>10</td>
</tr>
<tr>
<td>Cumulative score‡</td>
<td>695</td>
<td>90</td>
</tr>
</tbody>
</table>

Analyzed on SPSS for windows by analysis of variance (ANOVA).
Abbreviations: Class 2b plus, all cases classified as greater than 2a; BS, % best score.
* $F = 13.47, df = 1, p = .001$.
† $F = 20.75, df = 1, p = .0001$.
‡ $F = 6.09, df = 1, p = .02$.
favorable position if full dental rehabilitation is planned. If the defect involves the anterior maxilla (Figure 5), sufficient bone must be placed with any reconstructive technique to give support to the nose and provide bone in the desired position to retain implants for a denture.

Class 3. Class 3 is a high maxillectomy, which can include the orbital floor or part of the orbital tissues, but the globe is not resected. Maxillectomies that include the skull base may fall into this category, although these usually include an orbital exenteration. It is more likely that patients will have aesthetic problems associated with a high maxillectomy. Ectropion and enophthalmos may occur, and in some cases the cheek is not adequately supported, resulting in a poor facial appearance. Obturation can be successful in this group, but more problems occur with fitting a heavier appliance, and insertion may be difficult in the presence of trismus.

If reconstruction is the choice of treatment, attempts should be made to adequately support the orbital floor and cheek and provide bone for denture support. It is therefore more difficult to provide sufficient height and width of bone with a scapula or fibula flap. The vascularized iliac crest with internal oblique provides a method of closing large fistulas and providing sufficient bone to support the orbit and cheek and an implant-retained prosthesis if required. The composite radial forearm flap can be used for this type of defect, but the support of the cheek and the orbital contents may be less than ideal and provide inadequate bone for intra-oral implants. In Class 3b and c defects, loss of nasal support may occur if the whole of the septum has been resected, as well as contralateral sinuses and alveolus. Successful obturation would probably require to be implant retained, which could not be achieved for some months after the surgery.

Class 4. In Class 4 defects the main problem for the patient is the aesthetic change to the face after the loss of the orbit. Function is still important, but the restoration of a reasonable quality of life depends more on the aesthetic than functional result. Obturation can be difficult to achieve successfully during and after the inevitable course of radiotherapy in this patient group. The skin over
the orbit may break down, causing considerable distress for the patient and increased difficulties for the prosthodontist.

Reconstruction techniques need to close the fistula, ensure the healing of the eyelid skin, provide adequate bone to support the cheek and allow the wearing of a dental prosthesis, and sealing of the dura if a craniofacial resection has been necessary. The advantage of the DCIA with internal oblique is the extent of width and depth of bone from the generous donor site and the reliable and extensive muscle flap large enough to seal the cranium, obturate the orbit, and close the oro-nasal fistula (Figure 6). The epithelialization of the muscle in the oral and nasal cavities prevents ptosis of a skin flap and provides thin tissue, which facilitates the soft tissue prepasthetic surgery required in the placement of implants.

It is unusual for a Class 4 maxillectomy defect to be extended across the midline in the antral or palatal region. In this series, the initial DCIA reconstruction failed in 1 case of a Class 4b defect. Obturation was attempted but was unsatisfactory for the patient because the orbital skin was lost and the prosthesis poorly retained. The clinical situation was considerably improved by the fashioning of a bilobed latissimus dorsi flap to close the orbital and oral defects. Full dental rehabilitation has not been achieved at the time of writing.

The acceptance of any form of classification depends on its usefulness, clarity, and simplicity. The method must be logical, easy to remember, and so reduce the chances of ambiguity that may cloud any attempt at the comparison of different patient groups. As in most head and neck surgery, after survival the patient’s concerns are functional and aesthetic. This classification is the first attempt to combine both the likely functional and aesthetic outcomes and a relationship with rehabilitation choices.

Attempts to accurately classify the maxillectomy defect would result in an unnecessarily complex classification. As well as the level and extent of maxillectomy suggested in this classification, the extent of soft palate resection, nasal resection, skull base involvement, anterior or posterior maxillectomy, and the presence or absence of teeth may be incorporated. As part of the investigation and method in this study, each of these factors was considered, but the classification became extensive and was bound to be unworkable. In addition, various complex classifications were tested, with little improvement in information than that reported in this study.

The extent of soft palate resection is important in terms of functional outcome, but in most cases of maxillectomy resection resulting in an oro-antral fistula, the posterior rim of the soft palate is retained, which would maintain reasonable velopharyngeal competence and allow obturation with a fair functional result. Most patients undergoing soft palate resection, which included the posterior rim, had tumors arising in the retromolar region or the soft palate itself, resulting in a minimal posterior maxillectomy defect. This form of defect often may not result in a fistula into the antrum, and the oral and dental rehabilitation is often straightforward. Posterior maxillectomy defects have little bearing on the aesthetic outcome, and the need for a reconstruction rather than obturation will depend on the extent of the soft palate resection. It is acknowledged that the removal of the posterior rim of the soft palate is important and should be noted by the surgeon, but its inclusion in the main part of this classification would have made a more complex system with little gain in relevant information. By confining the classification to the maxillary sites (alveolus, palate, and
paranasal sinuses), the extent of the soft palate resection becomes less important. It is essential, therefore, to include the site of origin of the tumor in any attempt to compare functional and aesthetic outcomes in this patient group.

The dental status of the patient may indicate more successful obturation in the dentate group with improved retention of the prosthesis, but this depends on the site, number and health of the teeth, and gums left in place. To include these factors would have made the classification too complex. In some studies the presence of teeth may be an important factor that would need to be incorporated as part of the dental record.

The nasal walls are often included as part of the standard hemimaxillectomy (Class 2a). The lateral nasal wall is most commonly involved, but formal reconstruction of this structure is seldom carried out. In a similar fashion, the ethmoid and frontal sinuses do not require formal reconstruction. The inclusion of the nasal walls, ethmoid, and frontal sinus cavity defects without entry into the oral cavity have, therefore, been classified as Class 1. This reflects the likely good functional and aesthetic outcome with this form of minimal maxillectomy.

The removal of the nasal septum is potentially a cosmetic and functional problem for the patient, but this is seldom completely removed in a way that would result in nasal collapse. There is one case in this series of an anterior alveolar carcinoma, which required the removal of more than half the maxilla bilaterally in the anterior region, with the whole of the nasal septum. This case was classified as a Class 2b lesion, although the problems of nasal collapse will result in as much disfigurement and functional disadvantage as a Class 3 maxillectomy.

The site of the alveolectomy or palatal resection is important to the prosthodontist faced with the problem of obturation. Bilateral anterior defects pose more problems than the classical unilateral posterior hemimaxillectomy defect (Figure 4). An attempt was made to incorporate these factors into the alveolectomy part of the classification by use of the scoring system, which also in-
cluded the soft palate resection. This again made the classification complex and did not significantly alter the classified patient groups.

This classification is designed to predict the likely aesthetic and functional outcome for the patient and give some indication of the most suitable form of reconstruction. In Class 2 cases 8 of 13 (62%) of the defects reconstructed required a composite free flap compared with 100% of cases in Classes 3 and 4. In the Class 2 defects the vascularized iliac crest graft with internal oblique was used in 5 of 8 cases (63%) and in 7 of the 11 (64%) reconstructed cases in Classes 3 and 4. The other composite grafts were all radial forearm flaps, which reflect the practice of the unit before 1996, when this flap was used more commonly. Although a composite fibula or scapula flap provides sufficient bone for Class 2 defects, adequate bone replacement is more difficult to achieve in Class 3 and 4 defects by use of these free flaps. The vascularized iliac crest graft with internal oblique easily provides sufficient height and depth of bone for the replacement of the full height of the maxilla in Class 3 and 4 defects and

FIGURE 6. (A and B) Class 4a defect with a vascularized iliac crest graft with internal oblique muscle in place before closure. The muscle closes the oral defect and can be seen filling the orbital space. (C and D) Successful oral and facial rehabilitation (full upper denture worn on epithelialized muscle without implants).
can be adapted to reconstruct the alveolar part of the resection and the orbital floor.

The comparison of the quality of life outcomes between the Class 1 and 2a and Class 2b plus in a group of 30 patients was found to be significant (Table 3). In the Class 1 and 2a group, 8 patients were reconstructed and 8 were obturated, and in the Class 2b plus group 11 patients were reconstructed and only 3 were obturated. Although these are small numbers no significant differences were found between the method of rehabilitation in each group. It is interesting that both the activity and recreation questions scored significantly lower in the more extensive resections. This may reflect the need for more complex reconstruction or obturation in this group. In Class1 and 2a, of those patients completing the UoW questionnaire, only 2 of 6 (33%) reconstructed patients required composite free flaps, compared with 9 out of 11 (82%) in the Class 2b plus group. As expected, speech and chewing scored lower averages for the larger defects, but the other head and neck–specific questions (disfigurement, swallowing, and shoulder function) showed similar results. The similarity of the disfigurement score between the smaller and larger defects was surprising, but only 2 patients required orbital exenteration, and both wore full dentures and had implant-retained orbital prostheses. It is likely that the method of rehabilitation will require more complex treatments, likely to have a bearing on the quality of life, as the ablative defect becomes more extensive. Although this is a small comparative group, these results support this hypothesis and to some extent justify this suggested maxillectomy classification.

More surgeons are offering patient’s reconstruction and obturation in the management of the maxillectomy defect. At present, much controversy remains over the most suitable method of reconstruction and whether obturation will provide an adequate solution. It is hoped that the wide adoption of this classification will allow a fair comparison of maxillectomy defects in the continuing debate over the best form of facial and oral rehabilitation for these patients.

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