Mandibular Reconstruction: a new defect classification system

Arotiba GT, **Arotiba JT, *Bamgbose BO,*Gbotolorun MO,* Taiwo OA,Olasoji HO**

*Dept of Oral & Maxillofacial Surgery, School of Dental Sciences, College of Medicine, University of Lagos. **Dept of Oral & Maxillofacial Surgery, University College Hospital, Ibadan. ***Dept of Dental Surgery, University of Maiduguri Teaching Hospital, Maiduguri.

***Correspondence: Arotiba GT**
E-mail: drarotiba@yahoo.com

Abstract

This paper presents a new mandibular segmental defect classification system (La-Co-CE) with a view to highlight the complexity and difficulty of the reconstruction with free autogenous bone grafts which is the most frequently used method for surgeons practicing in developing countries. We submit that defect classification systems will continue to remain relevant if surgeons are to pre-operatively classify the envisaged operative difficulty and objectively compare the outcome postoperatively.

Introduction

The mandible is a major component of the human face. It provides a mobile platform for the dentition and a mobile frame for insertion of masticatory, tongue and suprahyoid muscles. It plays important functional roles in mastication, speech, deglutition, phonation, oral competence and facial aesthetics. [1-3] Reconstruction of mandibular defects is one of the most challenging operations that a surgeon can encounter because a satisfactory functional as well as a good aesthetic outcome must be concurrently achieved. [4-6] Recently, Tin Goh et al. [7] submitted that surgeons have been trying to reconstruct the mandible for more than a century and despite the enormous progress made over the last 40 years, the ideal system for mandibular reconstruction is yet to be developed.

Since Martin [2] described the immediate restoration of a resected segment of the mandible with a prosthetic appliance in 1889, several methods have been employed to reconstruct the mandible. These included Kirschner wire and metallic plates (essentially space maintainers), titanium or stainless steel, plastic (Dacron and polyurethane) trays with cancellous bone chips (alloplast – auto graft combination), bank bone (homografts), re-use of resected mandible after freezing in liquid nitrogen, boiling or sterilization with radiotherapy, calcium sulphate - cyanoacrylate material, particulate dentine – plaster of Paris combination, autogenous grafts, pedicled osteomyocutaneous flaps and microvascular transfers of bone and soft tissue. [2 – 11]

The size and complexity of the defect have been reported to influence the outcome of mandibular reconstruction by several authors. [12-15] Jewer et al's [16] Hemi-mandibular-Central –Lateral (HCL) classification of mandibular segmental defects took cognizance of the complexity of the reconstruction rather than the size or anatomic location of the defect. This paper will present a new defect classification system with a view to more accurately reflect the degree of difficulty of the reconstruction with autogenous cortico-cancellous bone grafts which remains the most frequently used method of reconstruction in developing countries.

Jewer et al"s hemi-mandibular-central-lateral (hcl) defect classification system

Jewer et al [16] in 1989, proposed the hemi-mandibular-central (HCL) defect classification system for mandibular defects. This was based on the complexity of the reconstruction rather than the size of the defect. The major anatomic landmarks used for this classification were the canines and the condyle. While central defects (C) are limited by both canines, the hemi-mandibular (H) and lateral (L) defects can be of varying sizes. Furthermore, condylar involvement or otherwise is the only distinguishing factor between lateral (L) and hemi-mandibular (H) defects. Arranged in order of increasing difficulty of the reconstruction, the HCL system will have eight different defect types:

1. L= unilateral defects from the symphysis menti to the ramus sparing the condyle
2. C = bilateral symphysial (bi-central) defects
3. H = condylar –lateral- hemi-central defects (the classic Hemi-mandibular defect).
4. LC = uni-Lateral and bi-central defects
5. LCL = lateral-bi-central-contra-lateral defects
6. HLC = condylar-lateral and bi-central defect
7. HLCL = Subtotal mandibular defect (condylar-lateral-bi-central-contra-lateral defects)
8. HLCLH = Total mandibular defect (condylar-lateral- bi-central-contra-lateral-condylar defects)

Urken et al"s c-r-b-s^{h}-s-b-r-c defect classification system

Urken et al [17] in 1991 proposed a more comprehensive mandibular defect classification system in that it classified the defects into bony, soft tissue and neurological defects/deficits. This system is mostly used in oncologic surgery. The bony defect classification recognizes 5 different anatomical regions of the mandible:

1. Condyle (C)
2. Ramus ®
3. Body (B)
4. Hemi-Symphysis (S^H)
5. Total Symphysis (S)

The new defect classification system (La-Co-Ce)
Rationale

A major shortcoming of Jewer et al's [16] classification is the rather nonspecific nature of both H and L defects. Therefore, it could be argued that the reconstructive difficulty of all H and L defects are not necessarily similar. For example, the classic hemi-mandibular defect involving loss of half of the symphysis menti and detachment of some of the genial muscle attachments should be more challenging to repair than one which is posterior to the canine or mental foramen.
Furthermore, anatomically it could be argued that the parabolic curve of the symphysial/ parasymphysial region do not end at the distal surface of the canines, but rather at the mental foramen in the premolar region. Therefore, it may be more appropriate to use the mental foramen as the anatomic landmark demarcating the lateral from the anterior regions of the mandible. Farwell and Futran [5] actually defined lateral defects as defects posterior to the mental foramen and below the condyle.
This new classification system will adopt Farwell and Futran's [5] definition of a lateral defect. It is our hope that it will accurately reflect the complexity of the reconstruction and the size of the bony defect. This is of relevance to surgeons practicing in developing countries who will continue to reconstruct these defects with free autogenous bone grafts until other recent advanced technology (microvascular surgery, distraction osteogenesis, tissue engineering etc) become affordable. The rationale for this new classification system is to use anatomic regions of the mandible to better delineate the size of the defect in other to reflect the envisaged difficulty of surgical reconstruction.
In this new system, whenever multiple areas of the mandible are involved, central defects will take precedence over lateral and condylar defects. Condylar defects will in turn take precedence over lateral defects. Therefore, there will be 24 distinct defect types in this classification system. Furthermore, it is arranged in order of increasing surgical difficulty of the reconstruction with autogenous bone grafts.
The 3 Anatomic zones of the Mandible (Fig. I)
For the purposes of this classification, the mandible will be divided into 3 anatomic regions/zones according to the degree of increasing surgical difficulty of the reconstruction with free autogenouss bone graft:

I. Lateral (body, angle, ramus) zone.
II. Condylar zone.
III. Central (symphysis and parasymphysis) zone.

Lateral zone (La)
Loss of a small segment of the ramus, angle and body of the mandible (lateral defects) produces minimal cosmetic and functional deficits. Apart from a deviation of the mandible to the resected side, mastication is generally satisfactory. These defects may therefore not be reconstructed, particularly when the patient is satisfied with facial aesthetics. [3, 5, 10]

Figure I- The 3 Anatomic zones of the mandible

Figure II - Lateral defects

Condylar zone (Co)
Loss of the temporo-mandibular joint is a unique challenge in mandibular reconstruction. It is virtually impossible to reproduce this articulation after disarticulation resections. Therefore some have recommended saving the condyle and the posterior segment of the ramus while still performing oncologically sound resections. [18] Others have advocated a reattachment of the condylar head as a free bone graft with miniplates. In young patients the use of costo-chondral grafts has been advocated to allow for further jaw growth. Sanger [18] submitted that "the main contribution of condylar reconstruction is to decrease lateral deviation and improve stability". He further submitted that the condyle contributes little to facial aesthetics; its absence has little effect on facial contour, the main defect is the absence of the ascending ramus which produces a 'caved in look' to the face. The aesthetic quality of the reconstruction is dependent on how well the angle and posterior aspect of the ascending ramus are reconstructed.

Central zone (CE)
Loss of the anterior part of the mandible (central defects) produces a severe crippling disability - collapse and medial rotation of the remaining posterior segments, results in

I. La 1: from the mental foramen to the distal surface of 2nd permanent molar.
ii. La 2: from mental foramen to the angle.
iii. La 3: from mental foramen to the ramus (sparing the condyle)
iv. La 4: Hemi-central defects (unilateral central defects between the symphysis menti and the mental foramen.

II. Condylar and Condylar-Lateral defects (Co-La): Defects with sacrifice of the condyle with varying degrees of lateral and hemi-central involvement. No bi-central involvement. This can be further subdivided into 4 subtypes depending on the extent of lateral and hemi-central involvement:
i. Co (Co1)
ii. Co-La3 (Co2)
iii. Co-La2 (Co3)
iv. Co-La1 (Co4)
v. Co-La4 (Co5)

Figure III - Condylar defects

III. Central defects (CE and CE-La): Bilateral central (bi-central) defects with varying degrees of lateral and condylar involvement. Defects anterior to the mental foramina, must be bilateral to qualify for inclusion as a central defect (Jewer s' criteria). If unilateral (Hemi-central defects) it should be regarded as a lateral defect because there will not be complete detachments of the genial tubercle muscles. Therefore, tongue ptosis, saliva drooling, lip incompetence and Andy Gump deformity may not be a prominent feature. Depending on the extent of lateral involvement, this can be further subdivided into true central defect (CE), central-uni-lateral (CE-La), central-bi-lateral (La-CE-La) defects, central-unicondylar defects (CE-Co) and central-bicondylar defects (Co-CE-Co):

III A. Central and Central-Uni-Lateral defects (CE and CE-La)
I. CE (Ce1)
ii. CE-La1 (Ce2)
iii. CE-La2 (Ce3)
iv. CE-La3 (CE4)

III B. Central -Bi-Lateral defects (La-CE-La)
i. La1-CE-La1 (CE5)
ii. La1-CE-La2 (CE6)
iii. La1-CE-La3 (CE7)
iv. La2-CE-La2 (CE8)
v. La2-CE-La3 (CE9)
vi. La3-CE-La3 (CE10)

III C. Central-Uni-Condylar defects
i. CE-Co (CE11)
ii. CE-Co +La1 (CE12)
iii. CE-Co +La2 (CE130
iv. CE-Co +La3 (CE14)

III D. Central-Bi-Condylar defects (Total mandibular defect)
I. Co-CE-Co (CE15)

Figure IV - Central & Central-Unilateral defects

severe facial deformity (Andy Gump deformity) and labial incompetence. [3-5] In addition, the loss of structural support for the lingual and suprahyoid musculature results in impaired tongue posture and laryngeal ptosis. [3, 5, 10] The resultant functional deficits include saliva drooling, dysphagia and inability to masticate, swallow and articulate. These functional and aesthetic deficits make the reconstruction and rehabilitation of central defects mandatory in most patients. Reconstructing these defects is regarded by many surgeons as the most challenging task in mandibular reconstruction. It has resulted in the greatest technical difficulty and complications. Reasons advanced for this include the difficulty of reproducing the double parabolic configuration of the symphysial/parasymphysial region, the interplay of the tongue and mentalis muscles and the rather thin, friable and limited width of oral mucosa in this area of the mandible. [3, 5, 10]

The New 24 Segmental Defect Types (Figs. 2, 3, 4, 5, 6).
I. Lateral defects (La): Defects of the body, angle, ramus and hemi-central defects. Depending on the specific anatomic sites involved this may also be subdivided into five subtypes:

In summary, this new classification system has 4 lateral type defects (La), 5 condylay type defects (Co), and 15 central type defects (CE). The 15 central type defects are in turn divisible into 4 central and central-uni-lateral defects (CE and CE-La), 6 central-bi-lateral defects (La-CE-La), 4 central-uni-condylar defects (CE-C0) and 1 central-bi-

Figure V - Central-Bilateral defects

Figure VI - Central- Uni-Condylar defects

condylar defect (Co-CE-Co). In this classification system, a central defect is defined as a defect that involves total resection of the sympysis with varying degrees of lateral and condylar involvement.

Merits and demerits of this classification system

With regards to reconstructive difficulty using autogenous bone grafts, three critical anatomical regions of the mandible can be identified:

1. The symphysial and parasymphysial region (central defects)
2. The condylar articulation (condylar defects)
3. The angle (the meeting point of the body and the ramus)

Therefore, it should be expected that defects that involve sacrifice of the angle will be more challenging to reconstruct than those that spares the angle. This was taken into consideration in this classification system. Thus a defect sparing both angles will be easier to reconstruct than one that involves sacrifice of one angle (which should in-turn be easier to reconstruct than one that involves sacrifice of both angles).

Figure VII - Central-Bi-Condylar defect (Total mandibular defect)

For surgeons practicing in developing countries, who will continue to take free cortico-cancellous bone graft to reconstruct mandibular defects, this classification system will serve as a guide to preoperatively classify the degree of envisaged surgical difficulty and objectively compare the results.

This defect classification system like Jewer et al"s is restricted to bony defects only. Its clinical use will therefore be restricted to surgery for aggressive benign lesions or oral cancers where adjacent/overlying soft tissues are not involved. This is in contrast to Urken et al"s CRBS^{H}S classification system which incorporated both hard and soft tissue defects as well as neurological deficits.

This defect classification system completely ignored alveolar and coronoid defects. The advent of new reconstructive technologies such as distraction osteogenesis and tissue engineering may reduce if not totally eliminate the relevance of defect classification systems.

Conclusion

Until relatively recent advances in distraction osteogenesis and tissue engineering become more predictable, affordable and universally available to surgeons practicing in developing countries, they will continue to take free autogenous bone grafts to reconstruct segmental defects of the mandible. Therefore, a defect classification system will continue to be a useful guide to preoperatively classify the degree of difficulty of the reconstruction and to objectively compare the outcome.

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