



Classification of Mandibulectomy/Mandibular Defects

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Abstract

Introduction: The mandible like other facial bones can be associated with pathological processes which can either be primary or secondary, usually being treated by resection of the affected portion of the mandible. There exist different mandibular defect classification; most of the available classifications are directed to mandibular defects following the surgical excision of mandibular tumors or composite defects due to various etiologies mentioned.

Materials and Methods: About 47 cases of mandibulectomy done at the oral and maxillofacial surgery department University College Hospital were reviewed and different patterns and distributions were observed and these were used to generate a spread sheet which was then analyzed using SPSS version 23. The result of this review was used to propose the classification.

Result: About 47 cases of mandibulectomies were reviewed and different portion of the mandible resected were recorded. The most common types of mandibulectomy was that of one side of the mandible crossing the midline to the other side, others include removal of the whole mandible, posterior mandibulectomy of one side not crossing the midline, anterior mandibulectomy crossing the midline, anterior mandibulectomy not crossing midline (one sided), one half of the mandible, part of the mandible without continuity defect.

Conclusion: The proposed mandibular defect/mandibulectomy is therefore based on these findings as follows:

- 1) Total mandibulectomy. 2) Partial mandibulectomy.
 - I. Segmental mandibulectomy
 - II. Hemi-mandibulectomy (right or left)
 - III. Subtotal mandibulectomy (right or left)
 - IV. Unilateral free end mandibulectomy (right or left)
 - V. Bounded unilateral segmental mandibulectomy (right or left)
 - VI. Bounded bilateral mandibulectomy
 - B. Marginal mandibulectomy

Keywords: Mandibulectomy; Mandibular defects; Parasymphseal; HCL

Introduction

The mandible is a U-shaped bone that articulates with the skull base through two unique Temporomandibular Joints (TMJs), a diarthrodial joint that consists of two bones articulating in a discontinuous fashion and allowing freedom of movement dictated by muscles and limited by ligamentous attachments, which allow smooth and coordinated mouth opening [1]. It bears 16 permanent teeth within the alveolus and these facilitate mastication [1].

Mandibular movement is provided largely by the four muscles of mastication, which consist of the masseter, temporalis, medial pterygoid, and lateral pterygoid. These muscles are all innervated by the mandibular division of the trigeminal nerve. Preserving the attachments of these muscles where possible during the resection prevents an imbalance in forces, which can result in pain and altered mouth opening, particularly after radiation therapy [2].

Many pathological processes affect the mandibular bone just like the other bones in the body, these pathologies can be primary or secondary, most of the time the ultimate treatment is mandibular resection with or without the surrounding soft tissues involved [1].

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Presently there is no universally accepted classification system of descriptive surgical relevance that exists for mandibular defects following mandibular resection or planned mandibulectomy. Most of the available classifications are directed to mandibular defects including bony defects of the mandible after surgical excision of mandibular tumors or composite defects due to various etiologies mentioned below.

Several attempts at classifying mandibular defects in a simple and practical way, to aid management, have been made as mentioned above and they have gradually reformed with time as the management for these defects has evolved. Of these, the one put forward by Boyd et al. [3] is the most commonly known system and the one by Schultz et al. [4] is the latest, others include: Pavlov [5] divided mandibular defects into 3 classes based on whether the remaining arch was left in 1, 2 or 3 fragments. (So, class 1 always involved a condyle and class 3 had 2 separate defects) [2].

David et al. [6] proposed a classification similar in spirit to HCL classification which was published shortly afterwards in 1989 (described below). They considered many reconstructive difficulties mainly related to the resection of condyle and the central segment. The disadvantages of this classification include some bony defects (like short H, HCH, HCL, and HC of HCL classification) and soft tissue defects which were not classified.

Urken et al. [7] proposed a CRBS classification was based on soft tissue and nerve defects in addition to bony defect, It's a comprehensive classification of composite oromandibular defects which includes 'neurological deficits' (8 possibilities) in addition to bony (20 possibilities) and soft tissue defects (22 possibilities). Bone defects- Condyle, Ramus, Body, and Symphysis (S-total, S^H: Superscript -H indicates- hemisymphysis defect), Superscript M to C/R/B/C- indicates marginal resection in that specific part of mandible [1,5].

Boyd et al. [3] modified the HCL classification to include soft tissue component into it in 1993 and this included soft tissue defects by adding 3 lower case alphabets (o,m,s) as subscripts to the 3 upper case alphabets (H,C,L) while classifying: 'o' refers no mucosal or skin component, 'm' refers mucosal component 's' refers skin component [1,3].

This is said to be the most popular classification and still in use for reconstruction of mandibular defects in the free- vascularized free flap era and it is primarily based on reconstructive difficulty [1,3]. Another classification by Schultz et al. [4] attempted to simplify mandibular defects classification and it focuses on the functional mandibular subunits lost and the 2 donor sites for free flaps commonly used for such reconstruction i.e., Fibular Osseoseptocutaneous (FOSC) flap and iliac crest osseocutaneous/DCIA (Deep Circumflex Iliac Artery) flap [1].

Many classifications of mandibular defects have been made and are found in the literature but none has seemed to be able to meet the criteria for global description of type of surgical procedural relevance that actually give a detail description of mandibulectomy procedure i.e., the part, extent and span of resected mandible; different nomenclatures have been used in the literature to describe the procedure or the defect as given above, and these sometimes differ from centre to centre. A unified classification system is therefore imperative for proper description of mandibulectomy procedure and for teaching purpose. Having reviewed scientific literatures on the classification of mandibular defects and forty-seven (47) cases of

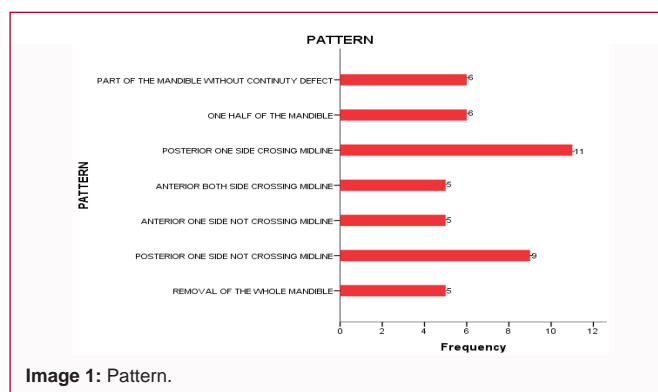


Image 1: Pattern.

mandibulectomy done at the University College Hospital Ibadan, a new classification system, with descriptions of surgical procedure and describing different types of mandibulectomy that can be used worldwide is here proposed

Results

About 47 cases of mandibulectomies were reviewed and different portion of the mandible resected were recorded. The most common types of mandibulectomy was that of one side involving the condyle of the mandible and crossing the midline to the other side, others include removal of the whole mandible, removal of the posterior aspect of the mandible of one side not crossing the midline, removal of the anterior aspect of one side of the mandible not crossing the midline, removal of the anterior aspect of the mandible crossing the midline (one sided), removal of one half of the mandible, removal of part of the mandible without continuity defect. The proposed mandibular defect/mandibulectomy is therefore based on these findings (Image 1).

Discussion

Based on the above findings, the following classification is then proposed.

Proposed classification of mandibular defects

1. Total mandibulectomy
2. Partial mandibulectomy
 - A. Segmental mandibulectomy
 - B. Marginal Mandibulectomy

A. Segmental mandibulectomy:

- i. Hemimandibulectomy (right or left)
- ii. Subtotal mandibulectomy (right or left)
 - a) Parasymphyseal subtotal mandibulectomy at X
 - b) Body subtotal mandibulectomy at X
 - c) Angle subtotal mandibulectomy
 - d) Ramus subtotal mandibulectomy
- iii. Unilateral free end mandibulectomy (right or left)
 - a) Parasymphyseal unilateral free end mandibulectomy at X
 - b) Body unilateral free end mandibulectomy at X
 - c) Angle unilateral free end mandibulectomy
 - d) Ramus unilateral free end mandibulectomy

- iv. Unilateral bounded segmental mandibulectomy (right or left)
 - a) Unilateral Ramus-Body mandibulectomy at X
 - b) Unilateral Ramus-Parasymphiseal mandibulectomy at X
 - c) Unilateral Ramus-Symphiseal mandibulectomy
 - d) Unilateral Angle-Body mandibulectomy at X
 - e) Unilateral Angle-Parasymphiseal mandibulectomy at X
 - f) Unilateral Angle-Symphiseal mandibulectomy
 - g) Unilateral Body-Body mandibulectomy at X-X
 - h) Unilateral Body-Parasymphiseal mandibulectomy at X-X
 - i) Unilateral Symphiseal-Body mandibulectomy at X
- v. Bilateral bounded segmental mandibulectomy (right or left)
 - a) Bilateral Ramus-Ramus mandibulectomy
 - b) Bilateral Ramus-Angle mandibulectomy
 - c) Bilateral Ramus-Body mandibulectomy at X
 - d) Bilateral Ramus-Parasymphiseal mandibulectomy at X
 - e) Bilateral Angle-Angle mandibulectomy
 - f) Bilateral Angle-Body mandibulectomy at X
 - g) Bilateral Angle-Parasymphiseal mandibulectomy at X
 - h) Bilateral Angle-Symphiseal mandibulectomy (Right or left)
 - i) Bilateral Body-Body mandibulectomy at X-X
 - j) Bilateral Body-Parasymphiseal mandibulectomy at X-X

B. Marginal mandibulectomy: X is the tooth that is removed for osteotomy or the tooth at the osteotomy site. Preference is given to the most posterior osteotomy site i.e., the most posterior osteotomy site come first in the description.

Description of terms (The shade areas in the illustrations signify the resected portion of the mandible)

1. Total mandibulectomy: Removal of the whole mandible including bilateral disarticulation (Figure 1).

2. Partial mandibulectomy: Resection of any part of the mandible, leaving the unaffected part intact e.g. segmental mandibulectomy and marginal mandibulectomy.

Segmental mandibulectomy: Resection of a portion of the mandible (i.e. a segment of the mandible is resected) and these include.

I. Hemimandibulectomy: Mandibulectomy involving the resection of one half of the mandible starting from the midline (Figure 2).

II. Subtotal segmental mandibulectomy: Mandibulectomy involving one half of the mandible, crossing the midline to involve a portion of the other half of the mandible. It is further divided into five classes descriptively as follows.

a) Parasymphiseal subtotal mandibulectomy at X (Right or left): A subtotal segmental mandibulectomy with the resection

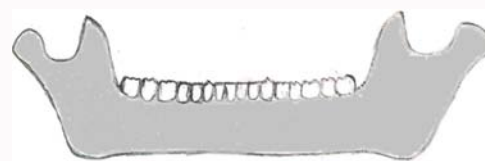


Figure 1: Total mandibulectomy.

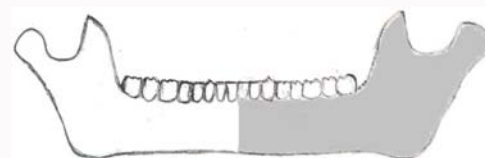


Figure 2: Hemi mandibulectomy.



Figure 3: Parasymphiseal subtotal mandibulectomy at x (right or left).



Figure 4: Body subtotal mandibulectomy at x (right or left).



Figure 5: Angle subtotal mandibulectomy (right or left).

of a segment from the Parasymphysis ($x=2$ or 3) on one side with disarticulation on the other. It can be right or left side (Figure 3).

b) Body subtotal mandibulectomy at X (Right or left): It is a subtotal segmental mandibulectomy with the resection of a segment from the body region ($x=3, 4, 5, 6$ or 7) on one side with disarticulation on the other side. It can either be right or left (Figure 4).

c) Angle subtotal mandibulectomy (Right or left): It is a subtotal segmental mandibulectomy with the resection of a segment from the Angle on one side with disarticulation on the other side. It can either be right or left (Figure 5).

d) Ramus subtotal mandibulectomy (Right or left): It is a subtotal segmental mandibulectomy with the resection of a segment from the ramus on one side with disarticulation on the other side. It can either be right or left (Figure 6).

e) Condylar subtotal mandibulectomy (Right or left): It is a subtotal segmental mandibulectomy with the resection of a segment leaving the condyle on one side intact and disarticulation on the other side. It can either be right or left (Figure 7).

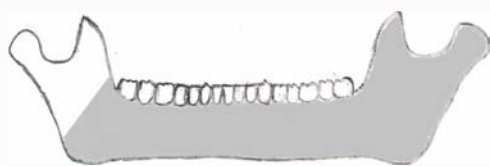


Figure 6: Ramus subtotal mandibulectomy (right or left).



Figure 7: Condylar subtotal mandibulectomy (right or left).



Figure 8: Parasymphyseal unilateral free end mandibulectomy at (right or left) X.

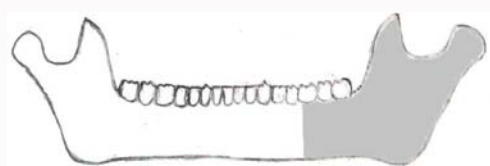


Figure 9: Body unilateral free end mandibulectomy at (right or left) X.

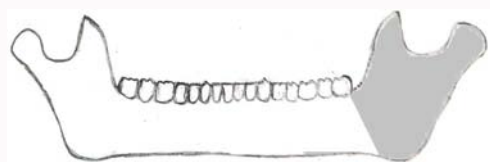


Figure 10: Angle unilateral free end mandibulectomy (right or left).

III. Unilateral Free End Mandibulectomy: This is a form of segmental mandibulectomy of half of the mandible that does not get to the midline but limited to area posterior to symphysis. It is further divided into five classes descriptively as follows.

a) **Parasymphyseal unilateral free end mandibulectomy at (Right or left) X:** This is a unilateral free end segmental mandibulectomy with osteotomy site at the parasymphysial region (X=2 or 3) and removing the posterior segment (Figure 8).

b) **Body unilateral free end mandibulectomy at (Right or left) X:** Parasymphyseal unilateral free end mandibulectomy at (Right or left) X: This is a unilateral free end segmental mandibulectomy with osteotomy site at the body region (X=2, 4, 5, 6 or 7) and removing the posterior segment (Figure 9).

c) **Angle unilateral free end mandibulectomy (Right or left):** This is a unilateral free end segmental mandibulectomy with osteotomy site at the angle region and moving the posterior segment (Figure 10).

d) **Ramus unilateral free end mandibulectomy (Right or**

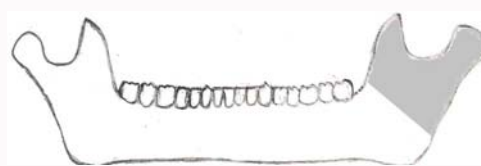


Figure 11: Ramus unilateral free end mandibulectomy (right or left).



Figure 12: Condylectomy (right or left).

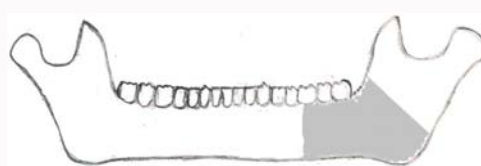


Figure 13: Unilateral ramus-body mandibulectomy at (right or left) X.



Figure 14: Unilateral ramus-parasymphyseal mandibulectomy at (right or left) X.

left): This is a unilateral free end segmental mandibulectomy with osteotomy site at the parasymphysial region and removing the posterior segment (Figure 11).

e) **Condylectomy (Right or left):** It is a subtotal segmental mandibulectomy with osteotomy site at the condylar neck. It can either be right or left and removing the posterior segment (Figure 12).

IV. Unilateral Bounded Mandibulectomy: Resection of the portion of half of the mandible anterior to the condyle. It is further divided into nine classes descriptively as follows.

a) **Unilateral Ramus-Body mandibulectomy at (Right or left) X:** A Unilateral bounded mandibulectomy with resection of a segment between the ramus and body (X=4, 5, 6 or 7) on the same side (Figure 13).

b) **Unilateral Ramus-Parasymphyseal mandibulectomy at (Right or left) X:** A Unilateral bounded mandibulectomy with resection of a segment between the ramus and parasymphysis (X=2 or 3) on the same side (Figure 14).

c) **Unilateral Ramus-Symphyseal mandibulectomy (Right or left):** A Unilateral bounded mandibulectomy with resection of a segment between the ramus and midline on the same side (Figure 15).

d) **Unilateral Angle-Body mandibulectomy at (Right or left) X:** A Unilateral bounded mandibulectomy with resection of a segment between the angle and body (X=4, 5, 6 or 7) on the same side (Figure 16).



Figure 15: Unilateral ramus-symphiseal mandibulectomy (right or left).



Figure 16: Unilateral angle-body mandibulectomy at (right or left) X.



Figure 17: Unilateral angle-parasymphiseal mandibulectomy at (right or left) X.

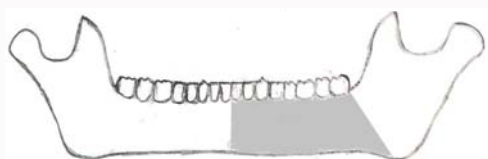


Figure 18: Unilateral angle-symphiseal mandibulectomy (right or left).

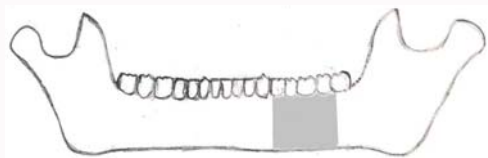


Figure 19: Unilateral body-body mandibulectomy at (right or left) X-(right or left) X.

e) Unilateral Angle-Parasymphiseal mandibulectomy at (Right or left) X: A Unilateral bounded mandibulectomy with resection of a segment between the Angle and parasymphysis (X=2 or 3) on the same side (Figure 17).

f) Unilateral Angle-Symphiseal mandibulectomy (Right or left): A Unilateral bounded mandibulectomy with resection of a segment between the Angle and symphysis (Figure 18).

g) Unilateral Body-Body mandibulectomy at (Right or left) X-(Right or left) X: A Unilateral bounded mandibulectomy with resection of a segment of the mandibular body (X=4, 5, 6 or 7) on the other side (Figure 19).

h) Unilateral Body-Parasymphiseal mandibulectomy at (Right or left) X-(Right or left) X: A Unilateral bounded mandibulectomy resection of a segment between the body (X=4, 5, 6 or 7) and parasymphysis (X=4, 5, 6 or 7) on the same side (Figure 20).

i) Unilateral Body -Symphiseal mandibulectomy at (Right or

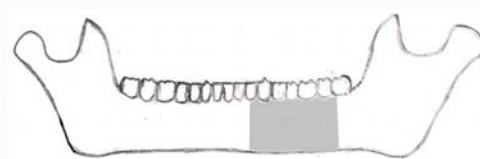


Figure 20: Unilateral body-parasymphiseal mandibulectomy at (right or left) X-(right or left) X.

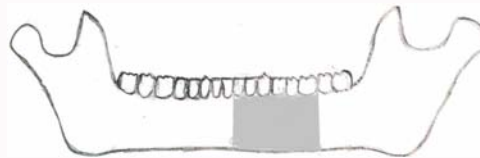


Figure 21: Unilateral body -symphiseal mandibulectomy at (right or left) X.



Figure 22: Bilateral ramus-ramus mandibulectomy (right or left).

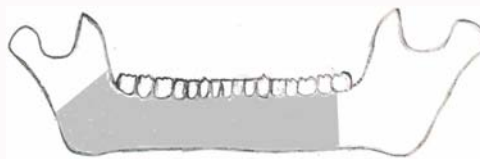


Figure 23: Bilateral ramus-body mandibulectomy at (right or left) X.

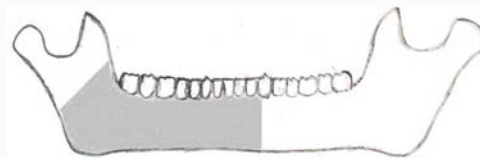


Figure 24: Bilateral ramus-parasymphiseal mandibulectomy at (right or left).

left) X: A Unilateral bounded mandibulectomy with resection of a segment between the body (X=4, 5, 6 or 7) and midline (Figure 21).

V. Bilateral Bounded Mandibulectomy: Resection of the anterior aspect of the mandible crossing the midline with intact posterior mandibular segment bilaterally. It is further divided into five classes descriptively as follows:

a) Bilateral Ramus-Ramus mandibulectomy (Right or left): Bilateral bounded Mandibulectomy with resection of a segment between the bilateral ramii (Figure 22).

b) Bilateral Ramus-Angle mandibulectomy (Right or left): Bilateral bounded mandibulectomy with the resection of a segment between the ramus on one side and angle on the other side.

c) Bilateral Ramus-Body mandibulectomy at (Right or left) X: Bilateral bounded mandibulectomy with the resection of a segment between the ramus on one side and body (X=4, 5, 6 or 7) on the other side (Figure 23).

d) Bilateral Ramus-Parasymphiseal mandibulectomy at (Right



Figure 25: Bilateral angle-angle mandibulectomy at (right or left) X.

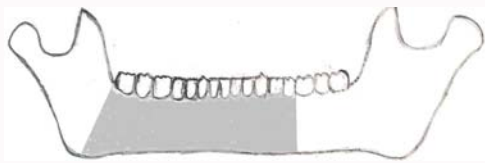


Figure 26: Bilateral angle-body mandibulectomy at (right or left) X.

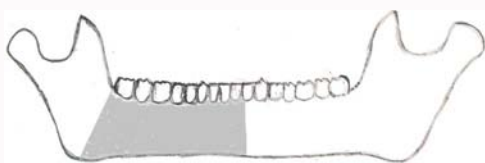


Figure 27: Bilateral angle-body mandibulectomy at (right or left) X.

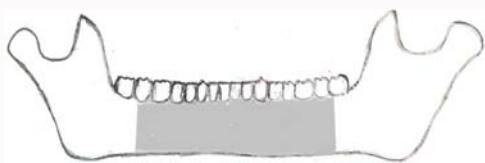


Figure 28: Bilateral body-body mandibulectomy at (right or left)X-(right or left) X.

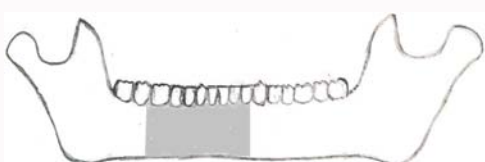


Figure 29: Bilateral body-body mandibulectomy at (right or left) X -(right or left) X.

or left) X: Bilateral bounded mandibulectomy with the resection of a segment between the ramus on one side and parasymphysis (X=2 or 3) on the other side (Figure 24).

e) Bilateral Angle-Angle mandibulectomy at (Right or left) X: Bilateral bounded mandibulectomy with the resection of a segment between the angle on one side and Angle on the other side (Figure 25).

f) Bilateral angle-body mandibulectomy at (Right or left) X: Bilateral bounded mandibulectomy with the resection of a segment between the Angle on one side and body (X=3, 4, 5, 6 or 7) on the other side (Figure 26).

g) Bilateral Angle-Parasymphyseal mandibulectomy at (Right or left) X: Bilateral bounded mandibulectomy with the resection of a segment between the Angle on one side and parasymphysis (X=2 or 3) on the other side (Figure 27).

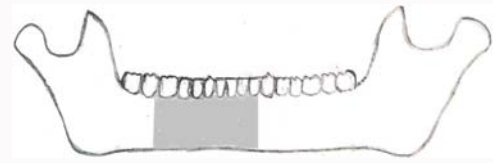


Figure 30: Bilateral parasymphyseal-parasymphyseal mandibulectomy at (right or left) X-(right or left) X.

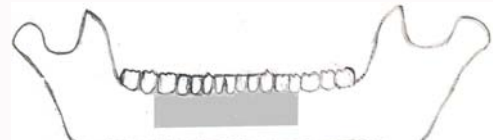


Figure 31: Marginal mandibulectomy.

h) Bilateral Body-Body mandibulectomy at (Right or left) X-(Right or left) X: Bilateral bounded mandibulectomy with the resection of a segment between the bilateral body (X=4, 5, 6 or 7) region (Figure 28).

i) Bilateral Body-Parasymphyseal mandibulectomy at (Right or left) X-(Right or left) X: Bilateral bounded mandibulectomy with the resection of a segment between the body on one side and parasymphysis on the other side (Figure 29).

j) Bilateral parasymphyseal - parasymphyseal mandibulectomy at (Right or left) X-(Right or left) X: Bilateral bounded mandibulectomy with the resection of a segment between the parasymphysial regions (X=2 or 3) region bilaterally (Figure 30).

Marginal mandibulectomy: Resection of a portion of the mandible without a continuity defect (Figure 31).

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