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# Classification Dilemmas of Mandibular Fractures: A Review

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## ABSTRACT

**Background**: Mandible is one of the many bones in an intricately arranged craniofacial skeleton. Mandibular fractures are not uncommon and have been well documented and thoroughly studied. Classification of mandibular fractures is one area which has been changing and updating ever since the first classification reported by Rowe and Killey. Classification helps in understanding the pattern of fracture and in communicating about the type of fracture. This paper gives an insight into most of mandibular fracture classifications.

**Keywords:** Classification, fractures, mandible, symphysis, body, angle, Rowe, Spiessl.

## INTRODUCTION

Mandibular fractures are one of the most frequently occurring fractures in the craniofacial region. Different intensities of impact lead to different injury patterns, therefore, it becomes crucial for practitioners to evaluate the type of injury for an efficient treatment planning. This is where the role of a classification system comes into picture. Classification helps in understanding the pattern of fracture and in communicating about the type of fracture. Various authors reported classifications on mandibular fractures. Many newer classifications have been proposed to address the shortcomings of the previous classifications. Any reported classification has its own merits and demerits and it is highly difficult to prepare a comprehensive classification for mandibular fractures which is simple to comprehend. This paper reviews mandibular fracture classifications till 2014. First reported classification was given by Rowe and Killey in the late 1950's

**Rowe and Killey (1958, 1965, 1999)[1,2,25]** categorized mandibular fracture sites into two main categories:

1) Alveolar fractures not involving the basal bone and
2) Fractures involving the basal bone.

The great majority of fractures were attributed to the second category. Single unilateral basal bone fractures were further subdivided into six regions (symphysis, canine, angle and body combined, ramus, coronoid, condyle). Fracture combinations within any of these regions were distinguished into double unilateral, bilateral and multiple fractures.

**Huelke et al (1961,1962)[3,4]** reported on 4 major fracture locations:

1) Chin fractures: between the mental foramina or the corners of the mouth,
2) Angle - body: fractures located between the gonial angle and the mental foramen,
3) Subcondylar: at the neck of the mandible and

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4) "Other" fractures: comprising the ramus, alveolar bone alone, and the coronoid process.

Mental foramen and a line anterior to the ramus downwards to the mandibular base were used in edentulous fractures.

**Dingman and Natvig (1964)[5]** have classified mandibular fractures into seven regions. They are symphysis, body, alveolar process, angle, ramus, condyle process, coronoid process. The roots of the lower canines and the borderlines of the angle region were considered as demarcating lines. Intercanine area of the mandible was called symphysis region. The area between the canine and the anterior boundary of the angle was called body region. A triangular area bounded by the anterior margin of the masseter muscle and by a line from the retromolar trigone to the "posterior superior attachment of the masseter to the ramus" was called angle region.

**Halazonetis (1968)[6,25]** with the aim to determine the "weak" regions of the mandible regarding the state of dentition, used elements of both Rowe & Killey and Dingman & Natvig classifications, as well as Huelke landmarks to match identical regions in dentulous and edentulous jaws. Mandibular fractures were classified under seven regions/hemimandible: symphysis (lower incisors), canine including first premolar, molar region (second premolar, first and second molar), angle region including third molar, ramus, coronoid and condyle.

**Spiessl and Schroll (1972)[7]** added the glenoid fossa to the already existing, Rowe & Killey and Dingman & Natvig classifications. His classification consisted symphysis, body, alveolar process, angle, ramus, condyle process, coronoid process and glenoid fossa.

**Kelly and Harrigan (1975)[8,25]** adhered to the prototypical mandibular divisions of former classifications. Six categories for hemimandible: symphysis (lower incisors), body (mesial aspect of canine to distal aspect of second molar), angle (retromolar area distal to second molar to inferior border of the body and posterior border of the ramus), ascending ramus (horizontal fractures through anterior and posterior borders or vertical from the notch to inferior mandible border), coronoid and condyle.

The most popular classification of mandibular fractures in Russian stomatological practice is the classification of **Kabakov and Malishev (1981)[9]**. According to them fractures are systemized as following:

According to localization:

1) Mandibular body/with or without teeth in fracture line

a. Mandibular ramus with its processes
b. According to the character: with or without dis-location

2) According to the number: single, double, multiple, unilateral, bilateral. Authors themselves found this classification incomplete and inexhaustible.

**Krüger (1982)[10]** devised a fracture classification and terminology that entered the AO CMF Manual later years with the fracture sites borrowed from Dingman and Natvig again. Fracture were localized into seven regions, they were symphysis (between canines), canine, body (between canines and angle), angle (=third molar region), ramus (between angle and sigmoid/mandibular notch), coronoid, condyle.

**Spiessl (1989)[11,25]** based on the preparatory work of Grätz (1986) introduced the acronym FLOSA, which expands as

- F = fracture category
- L = localization/fracture site
- O= occlusion
- S = soft tissue involvement
- A = associated fractures

A new site-specific terminology was created to label the anatomic regions, which reproduced the Dingman and Natvig scheme. The allocation of a fracture line to a region was determined by its course in the basal zone of the mandible, irrespective of the dentoalveolar or interdental pathway. (L = Localization, L1 = Precanine, L2 = Canine, L3 =Post canine, L4 = Angular, L5 = Supraangular, L6 = Condylar process, L7 = Coronoid process, L8 = Alveolar process)

**Cooter and David (1989, 1999)**[12,13] defined each hemimandible as one of 10 major unilateral anatomical zones and divided it ostensibly into 7 subzones: MD for mandible consisting of: D (dentoalveolar), S (Symphyseal), B (Body), A (Angle), R (Ramus), P (Coronoid process), C (Condyle).

Accounting for embryological, developmental, biomechanical, etiopathogenic, and epidemiological background knowledge, **Gola et al (1996)**[14] remodeled existing classifications with the claim to preclude terminological imprecision and to better comply the borderlines between the regions with the variation in anatomic and clinical reality of mandibular fractures. They designed straight "interregional" lines with angulation both in the frontal and the sagittal plane. The lines pass through dental crowns (canine and third molar), bony landmarks (mental foramen, preangular, and sigmoid notch), or the margins of the masseter muscle. In the sagittal plane, the three lines through the canine and mental foramen (= symphysis-ramus boundary), from the retromolar fossa to the preangular notch or the anteroinferior masseter insertion, respectively (= "interbody-ramus" border), and from the sigmoid notch to the posteroinferior masseter insertion (= "interangle-condyle" demarcation) are arranged in parallel. Thus, in the edentulous mandible the interregional separation lines can be elegantly installed in a posterior-anterior fashion with these parallels just touching bony landmarks.

In the first approach to establish a mandibular fracture severity score, **Joos et al (1999)**[15] attributed a value ranging from 0 to 3 points depending on the anatomic location into the summation of the total score with a possible maximum of 15 points. The angle/ramus was grouped as a single anatomic constituent with three points as the highest location score. Score: Symphysis = 0; premolar region = 1; molar region = 2; angle/ramus = 3

**Pankratov and Robustova (2001)**[16] proposed a reappraisal of Spiessl (1989) FLOSA classification equipped with surplus features (T=Teeth, D=Dislocation, I=Infection) was proposed by as FTLDOSIA but failed due to overload and inapplicability for routine purposes. FTLDOSIA formula/hemimandible: F (Fracture), T (Teeth), L (Localization), D (Displacement), O (Occlusion), S (Soft tissue), I (Infection), A (Associated fractures) Localization: L1 - L8: identical to Spiessl.

**F - Fracture**

- F0 to F4 and includes: incomplete, simple, double and multiple fractures

**T- Tooth**

- T0, T1, T2/T2 c, T2 pu, T2pe, T2pa - includes information concerning tooth-periodontal or parodontal changes of tooth in the fracture line

**L - Localisation**: from L1 to L8 and includes the following regions:

- L1 - incisors
- L2 - canine
- L3 - premolars-molars
- L4 - angle of mandible
- L5 - ramus of mandible
- L6 - condylar process
- L7 - coronoid process
- L8 - alveolar process

**D - Dislocation**

- D0, D1, D2-with luxation

**O - Occlusion**

- O0, O1, O2 - with or without occlusal changes /including classification of bone atrophy of the mandible
- O2-aI, O2-aII, O2-aIII; aI, II, III mark the bone atrophy of mandible

**S - Soft tissue**

- S0-closed mandibular fracture
- S1-open mandibular fracture /communication with oral cavity
- S2-open combined with skin injuries
- S3-intra and extraoral opened fractures
- S4- open fracture with soft tissue formations

**I - Infection**

- I0, I1, I2 – with or without inflammatory changes/abscess and phlegmons

**A - Associated**

- A0, A1 – combined or not

According to WHO **(1997, 2003)**[17] the international classification of mandibular fractures is:

- S 02.6 - Fractura mandibulae
- S 02.60 - Fractura processus alveolaris
- S 02.61 - Fractura corpus mandibulae
- S 06.62 - Fractura processus articularis, condylaris
- S 06.63 - Fractura processus muscularis, coronoideus
- S 02.64 - Fractura ramus mandibulae
- S 02.05 - Fractura symphysis
- S 02.66 - Fractura angulus mandibulae
- S 02.67 - Fracturae mandibulae multiplex
- S 02.68 - Unspecified mandibular fractures

The term "unspecified mandibular fractures" having in mind the contemporary apparatus is not correct.

In a study on the comparative performance of helical CT versus Panorex tomography, **Roth et al (2005)**[19,25] relied on an anatomical diagram of the mandibular regions to identify the fracture location. The borders of the topographical division into regions were not described. Division of each hemimandible into: anterior mandible; symphysis, parasymphysis, body, posterior mandible, angle, ramus, subcondylar, condylar was done.

With the aim to set up an improved "Mandible Injury Severity Score" (MISS), **Shetty et al (2007)**[20,25] made use of most of the individual FLOSA components. Instead of recording associated fractures (A), they included measures for infection (I) and interfragmentary displacement (D) modifying the previous acronym into FLOSID. The relative impact on the clinical outcome of each individual component was multiplied by a corresponding weighting factor and the resulting points were added to a summary score rating the injury severity. Apart from a graphical scheme displaying the anatomic regions similarly to Spiessl proposal, the borderlines were not verbally specified. The interregional demarcations of this scheme are self-explaining if they extend from interdental spaces but they appear at random in the anatomical ramus due to the lack of definite landmarks. A valuable remark is made, on where to assign fractures which extend across two adjoining anatomic regions. Referring to Spiessl "determining zone," such fractures are suggested to be allocated to the basal region that is predominantly involved.

**Follmar et al (2007)**[21] gave a site-specific radiographic classification of simple fracture types in the entire mandible: symphyseal (= midline), parasymphyseal (= between canines; in edentulism = between mental foramina), body (= between canine and second molar), angle, ramus, subcondylar, condylar, coronoid processes.

**Buitrago-Téllez et al (2008)**[22] reported a classification scheme in accordance with the AO/ASIF "Tripartite"- principle used in long bones and pelvis. It was exclusively based on imaging analysis. Various factors with regards to the fracture patterns were considered and given in a numerical formula. The AO/ASIF scheme, defining three fracture types (A, B, C), three groups within each type (e.g. A1, A2, A3) and three subgroups within each group (e.g. A1.1, A1.2, A1.3) with increasing severity from A1.1 (lowest) to C3.3 (highest) was used. The mandible is divided into two vertical units (I and V), two lateral horizontal units (II and IV) and one central unit (III) comprising the symphyseal and parasymphyseal region. Type A fractures are nondisplaced, type B are displaced and type C are multifragmentary/defect injuries. Groups and subgroups are further defined in the classification system.

**Carinci et al (2009)**[23,25] came up with a Facial Fracture Severity Score (FFSS) "scoring" method to stage mandibular fractures. Besides the anatomic sites [symphysis (= interforaminal area), body, angle, ramus, coronoid, condyle; Horizontal and vertical subunit grid/hemimandible: teeth containing alveolar process and basal bone] they also accounted for the type (incomplete/complete) and number of fracture lines in the alveolar process

and/or the basal arch (single/double/triple) to indicate the severity stage.

**Catapano et al (2010)**[24] topographical fracture location in the entire mandible: parasymphyseal (= intercanine area), body, angle (= strip with the width of the third molar), vertical ramus (= retromolar area behind third molar to sigmoid notch), condylar head and neck (extraarticular), condylar head and neck (intra-articular), glenoid fossa (intra-articular).

**Carl-Peter Cornelius et al (2014)**[25] reported a comprehensive AOCMF level 2 classification in which mandibular fractures were classified by the anatomic regions involved. For this purpose, the mandible is delineated into an array of nine regions identified by letters: the symphysis/ parasymphysis region anteriorly, two body regions on each lateral side, combined angle and ascending ramus regions, and finally the condylar and coronoid processes. A precise definition of the demarcation lines between these regions is given for the unambiguous allocation of fractures. Four transition zones allow an accurate topographic assignment if fractures end up in or run across the borders of anatomic regions. These zones are defined between angle/ramus and body, and between body and symphysis/parasymphysis. A fracture is classified as "confined" if it is located within a region, in contrast to a fracture being "non-confined" when it extents to an adjoining region. Illustrations and case examples of mandible fractures are presented to become familiar with the classification procedure in daily routine.

**Carl-Peter Cornelius et al (2014)**[26] reported a classification which is AOCMF image-based classification system for fractures of the mandibular arch (i.e. the non-condylar mandible) at the precision level 3. It is the logical expansion of the fracture allocation to topographic mandibular sites outlined in level 2, and is based on three-dimensional (3D) imaging techniques/ computed tomography (CT)/cone beam CT). Level 3 allows an anatomical description of the individual conditions of the mandibular arch such as the preinjury dental state and the degree of alveolar atrophy. Trauma sequelae are then addressed: (1) tooth injuries and periodontal trauma, (2) fracture involvement of the alveolar process, (3) the degree of fracture fragmentation in three categories (none, minor, and major), and (4) the presence of bone loss. The grading of fragmentation needs a 3D evaluation of the fracture area, allowing visualization of the outer and inner mandibular cortices. To document these fracture features beyond topography the alphanumeric codes are supplied with distinctive appendices.

## CONCLUSION

The very basic requirement of a classification system is simplicity and ability to incorporate various factors. In case of mandibular fractures, various factors which need to be incorporated in a comprehensive classification are the impact of injury, degree of displacement, soft tissue injury, extent of fracture line, status of dentition and occlusion, effects on TMJ, financial burden so on and so forth. This review gives us a perspective into various thought processes and dilemmas on the mandibular fracture classifications in past few decades and also a window for newer generations to refine the older versions and if feasible create a comprehensive, yet simple to understand classification system.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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