Relationship between mandibular condyle and angle fractures and the presence of mandibular third molars

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Abstract (J Korean Assoc Oral Maxillofac Surg 2015;41:3-10)

Objectives: We retrospectively evaluated the impact of mandibular third molars on the occurrence of angle and condyle fractures.

Materials and Methods: This was a retrospective investigation using patient records and radiographs. The sample set consisted of 440 patients with mandibular fractures. Eruption space, depth and angulation of the third molar were measured.

Results: Of the 144 angle fracture patients, 130 patients had third molars and 14 patients did not. The ratio of angle fractures when a third molar was present (1.26 : 1) was greater than when no third molar was present (0.19 : 1; odds ratio, 6.58; $P<0.001$). Of the 141 condyle fractures patients, the third molar was present in 84 patients and absent in 57 patients. The ratio of condyle fractures when a third molar was present (0.56 : 1) was lower than when no third molar was present (1.90 : 1; odds ratio, 0.30; $P<0.001$).

Conclusion: The increased ratio of angle fractures with third molars and the ratio of condyle fractures without a third molar were statistically significant. The occurrence of angle and condyle fractures was more affected by the continuity of the cortical bone at the angle than by the depth of a third molar. These results demonstrate that a third molar can be a determining factor in angle and condyle fractures.

Key words: Bone fracture, Trauma, Tooth

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likelihood of mandibular angle fractures by 1.9 fold. On this basis, some authors have recommended the early removal of an asymptomatic impacted third molar to prevent mandibular angle fractures. In contrast, a recent study reported that the absence of an impacted mandibular third molar was closely associated with mandibular condyle fractures in that it increased the likelihood of mandibular condyle fractures and reduced the incidence of mandibular angle fractures.

In this study, we investigated the impact of the presence of an impacted mandibular third molar and the type and position of the impaction on the occurrence of mandibular angle and condyle fractures.

II. Materials and Methods

1. Subjects

A retrospective study was conducted on 440 patients who visited the Department of Oral and Maxillofacial Surgery, Chosun University Dental Hospital (Gwangju, Korea), primarily because of mandibular fractures, between January 2008 and June 2012. We got approval of Chosun Dental Hospital Clinical Trial Center Institutional Review Board (CDM-DIRB-1428-158).

2. Methods

1) Classification by gender, age, and cause of fracture

Data were collected from the electronic medical records and panoramic radiographs of the patients. The subjects were classified by gender, age, cause of the fracture, presence and impaction type of the mandibular third molar, and the mandibular fracture site. Causes of injury were classified as falls, slips, traffic accidents, assault, and other.

2) Classification of mandibular fracture sites

Based on the classification scheme of Kelly and Harrigan, mandibular fracture sites were classified into the condylar process, coronoid process, ramus, angle, body, and symphysis. A mandibular angle fracture was defined as a fracture occurring at a site ranging from a point on the curve in the connecting part between the posterior region of the mandibular second molar and the ramus to a point on the curve formed by the lower and posterior borders of the mandible. A mandibular condyle fracture was defined as a fracture above a line drawn from the mandibular notch to the posterior border of the ramus, and fractures in the condyle head, condyle neck, and subcondyle were considered to be in this category.

3) Classification of mandibular third molar positions and angulation

Panoramic radiographs of the patients were used to determine the presence/absence of the mandibular third molar at the time the fracture occurred. When the mandibular third molar was present, classification was decided by eruption space and impaction depth, according to the method of Pell and Gregory. An additional classification was made based on the angulation of the mandibular third molar, following the method of Shiller (Fig. 1).

The horizontal positions of mandibular third molars were evaluated by eruption space on the basis of the relationship between the anterior border of the ramus and the distal side of the mandibular second molar. The crown and width of the mandibular third molar was measured. Then, the presence of sufficient eruption space between the distal side of the mandibular second molar and the anterior border of the ramus was categorized as class I, insufficient space leading to incomplete eruption as class II, and the presence of most of the mandibular third molar within the ascending ramus resulting in no eruption as class III.

The vertical positions of the mandibular third molars were evaluated by impaction depth. When the highest point of the mandibular third molar was at the same position, or at a higher position, as the occlusal plane of the mandibular second molar, this was categorized as level A. When the highest point was found to be between the occlusal plane of the mandibular second molar and the cementoenamel junction, this was categorized as level B, and when the highest point was found to occur at the lower side of the cementoenamel junction, this was classified as level C.

Regarding the angulation of the mandibular third molar,
when the angle between the occlusal surface of the mandibular second molar and that of the mandibular third molar was 10° or less to the mesial-distal direction, this was categorized as vertical angulation. Angles between 11°-70° to the mesial direction were considered mesial angulation, while angles between 11°-70° to the distal direction were considered distal angulation. Angles of 71° or greater or those that were parallel were considered horizontal angulation. The presence of a mandibular third molar with no root development was categorized as a tooth germ.

4) Statistical analysis
On the basis of these classifications, the data were analyzed using the SPSS Statistics software version 17.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was determined using the chi-squared and Fisher’s exact tests.

III. Results

1) Distribution of mandibular fractures by gender, age, and fracture sites
In total, 440 patients had a mandibular fracture; 348 males (79.1%) and 92 females (20.9%) at 645 sites. Among these patients, 109 patients (24.8%) were teenagers, 88 patients (20.0%) were in their twenties, and 54 patients (12.3%) were in their thirties. Of the 645 fracture sites, 235 sites (36.4%) were in the symphysis, 217 sites (33.6%) were in the condyle, and 158 sites (24.5%) were in the angle.

2) Distribution of mandibular angle and condyle fractures by gender, age, and cause of fracture
Among the mandibular fracture patients, 156 patients had a mandibular angle fracture at 158 sites. These included 139 males (89.1%) and 17 females (10.9%). Of these, 58 patients were teenagers, 52 patients were in their twenties, 24 patients were in their thirties, and 13 patients were in their forties.

In total, 190 patients had mandibular condyle fractures at 217 sites; 133 males (70.0%) and 57 females (30.0%). Of these, 46 patients were teenagers, 36 patients were in their twenties, 41 patients were in their thirties, and 32 patients were in their forties.

The most frequent causes of mandibular angle fractures were assault (36 patients, 23.1%), being struck by an object (32 patients, 20.5%), and falls and slips (30 patients, 19.2%), while the most frequent causes of mandibular condyle fractures were falls (53 patients, 27.9%), traffic accidents (46 patients, 24.2%), slips (37 patients, 19.5%), and assaults (21 patients, 11.1%).

3) Relationship between the presence of mandibular third molars and mandibular angle and condyle fractures
To investigate the association between mandibular third molars and mandibular angle and condyle fractures, 320 patients with a unilateral mandibular fracture, due to lateral force, were categorized by the presence of mandibular third molars, angle fractures, and condyle fractures on the basis of age. Patients whose fracture was not caused by lateral force, including those with only a symphysis fracture or with a bilateral condyle fracture, and those with both angle and condyle fractures, were excluded.

Of the 144 mandibular angle fracture patients, 130 patients had a mandibular third molar and 14 patients did not; the ratio of angle fractures was statistically significantly higher when the mandibular third molar was present (1.26 : 1) than when it was not (0.19 : 1; odds ratio, 6.58; *P*<0.001).

Of the 141 mandibular condyle fracture patients, 84 patients had a mandibular third molar and 57 patients did not; the ratio of condyle fractures was statistically significantly lower when a mandibular third molar was present (0.56 : 1) than when it was not (1.90 : 1; odds ratio, 0.30; *P*<0.001).

4) Relationship between mandibular third molar position and mandibular angle and condyle fractures
Based on the classification of mandibular third molars by their eruption space and impaction depth, the ratio of angle

| Table 1. Relationship between mandibular third molars and angle and condyle fractures |
|-----------------------------------------------|-----------------|-----------------|-----------------|---|---|---|
| Mandibular third molars | Angle fracture | Condyle fracture | Total |
| Present | Absent | Ratio | Present | Absent | Ratio | Present | Absent | Ratio | Total |
| Present | 130 | 103 | 1.26 : 1 | 84 | 149 | 0.56 : 1 | 233 |
| Absent | 14 | 73 | 0.19 : 1 | 57 | 30 | 1.90 : 1 | 87 |
| Total | 144 | 176 | 0.82 : 1 | 141 | 179 | 0.79 : 1 | 320 |

Values are presented as patients’ number or ratio.

*P*<0.001.

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fractures was highest in class II (1.61 : 1) and level B (1.73 : 1) and was statistically significant in the case of class alone (P<0.05). The ratio of condyle fractures was highest in class 0 (1.90 : 1) and level 0 (1.90 : 1) and was also statistically significant in the case of class alone (P<0.05). It was second highest in class I and level A with respect to condyle fractures.(Tables 2, 3)

Based on both the eruption space and impaction depth of the mandibular third molars, mandibular angle fractures were most frequent in class II/level B (1.92 : 1), excluding

### Table 2. Relationship between ramus position of mandibular third molar and angle and condyle fractures

| Ramus position | Angle fracture | Condyle fracture | Total |
|----------------|----------------|------------------|-------|
|                | Present | Absent | Ratio  | Present | Absent | Ratio  |       |
| Class 0        | 14     | 73     | 0.19 : 1| 57      | 30     | 1.90 : 1| 87    |
| Class I        | 19     | 29     | 0.66 : 1| 25      | 23     | 1.09 : 1| 48    |
| Class II       | 87     | 54     | 1.61 : 1| 43      | 98     | 0.44 : 1| 141   |
| Class III      | 24     | 20     | 1.20 : 1| 16      | 28     | 0.57 : 1| 44    |
| Total          | 144    | 176    | 0.82 : 1| 141     | 179    | 0.79 : 1| 320   |

Class 0: missing mandibular third molar, Class I: adequate space for eruption, Class II: inadequate space for eruption, Class III: located partially or completely in the ramus.

Values are presented as patients’ number or ratio.

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### Table 3. Relationship between impaction depth of mandibular third molars and angle and condyle fractures

| Impaction depth | Angle fracture | Condyle fracture | Total |
|-----------------|----------------|------------------|-------|
|                 | Present | Absent | Ratio  | Present | Absent | Ratio  |       |
| Level 0         | 14     | 73     | 0.19 : 1| 57      | 30     | 1.90 : 1| 87    |
| Level A         | 52     | 48     | 1.08 : 1| 40      | 60     | 0.67 : 1| 100   |
| Level B         | 57     | 33     | 1.73 : 1| 29      | 61     | 0.48 : 1| 90    |
| Level C         | 21     | 22     | 0.95 : 1| 15      | 28     | 0.54 : 1| 43    |
| Total           | 144    | 176    | 0.82 : 1| 141     | 179    | 0.79 : 1| 320   |

Level 0: missing mandibular third molar. Level A: level at occlusal plane, Level B: between the cementoenamel junction of the second molar and occlusal plane, Level C: below the cementoenamel junction of the second molar.

Values are presented as patients’ number or ratio.

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### Table 4. Angle fracture associated with ramus position and impaction depth of mandibular third molars

| Mandibular third molar position (class/level) | Angle fracture |
|---------------------------------------------|----------------|
|                                             | Present | Absent | Ratio  | Total |
| I/A                                         | 15     | 29     | 0.52 : 1| 44    |
| II/A                                        | 31     | 18     | 1.27 : 1| 49    |
| III/A                                       | 6      | 1      | 6 : 1   | 7     |
| I/B                                         | 1      | 0      | 0 : 1   | 1     |
| II/B                                        | 46     | 24     | 1.92 : 1| 70    |
| III/B                                       | 10     | 9      | 1.11 : 1| 19    |
| I/C                                         | 3      | 0      | 0 : 3   | 3     |
| II/C                                        | 10     | 12     | 0.83 : 1| 22    |
| III/C                                       | 8      | 10     | 0.80 : 1| 18    |
| Total                                       | 130    | 103    | 1.26 : 1| 233   |

Class I: adequate space for eruption, Class II: inadequate space for eruption, Class III: located partially or completely in the ramus.

Level A: level at occlusal plane, Level B: between the cementoenamel junction of the second molar and occlusal plane, Level C: below the cementoenamel junction of the second molar.

Values are presented as patients’ number or ratio.

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### Table 5. Condyle fracture associated with ramus position and impaction depth of mandibular third molars

| Mandibular third molar position (class/level) | Condyle fracture |
|---------------------------------------------|------------------|
|                                             | Present | Absent | Ratio  | Total |
| I/A                                         | 25     | 19     | 1.32 : 1| 44    |
| II/A                                        | 14     | 35     | 0.40 : 1| 49    |
| III/A                                       | 1      | 6      | 1.67 : 1| 7     |
| I/B                                         | 0      | 1      | 0 : 1   | 1     |
| II/B                                        | 21     | 49     | 0.43 : 1| 70    |
| III/B                                       | 8      | 11     | 0.73 : 1| 19    |
| I/C                                         | 0      | 3      | 0 : 3   | 3     |
| II/C                                        | 8      | 14     | 0.57 : 1| 22    |
| III/C                                       | 7      | 11     | 0.64 : 1| 18    |
| Total                                       | 84     | 149    | 0.56 : 1| 233   |

Class I: adequate space for eruption, Class II: inadequate space for eruption, Class III: located partially or completely in the ramus.

Level A: level at occlusal plane, Level B: between the cementoenamel junction of the second molar and occlusal plane, Level C: below the cementoenamel junction of the second molar.

Values are presented as patients’ number or ratio.

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IV. Discussion

The frequency of mandibular fractures can vary for many reasons. Mandibular fractures caused by assault occur most frequently in the mandibular body while those caused by falls occur most frequently in the mandibular condyle.\(^\text{24,25}\) The presence of the mandibular third molar can lead to the more frequent occurrence of mandibular angle fractures, as noted by many authors. Reitzik et al.\(^\text{6}\), who examined mandibular angle fractures in monkeys with impacted mandibular third molars, reported that these monkeys easily suffered fractures because the fracture strength was approximately 60% compared to the normal mandible. Tevepaugh and Dodson\(^\text{12}\) found that a mandibular angle fracture was 3.8 times more likely to occur when the mandibular third molar was present than when it was absent, and that the likelihood of fracture was not correlated with eruption of the mandibular third molar. In contrast, Safdar and Meechan\(^\text{11}\) observed that the presence of an impacted mandibular third molar could be a critical factor causing mandibular angle fractures because patients with it were more likely to get fractures. Furthermore, the larger the volume the mandibular third molar occupied in the mandibular angle, the more likely a mandibular angle fracture was to occur, due to the smaller area of the broken bone in the mandibular angle.

Cho et al.\(^\text{26}\) developed a three-dimensional (3D) finite element model for the mandible, including the temporomandibular...
mandibular angle, the external force is divided by the mandibular angle, thus reducing the likelihood of mandibular condyle fractures. Conversely, when the mandibular angle is intact, the external force is delivered to the mandibular condyle, causing a mandibular condyle fracture. 

In this study, mandibular fractures were seen more frequently among young men, and the incidence of mandibular condyle fractures was more affected by age, compared with the incidence of mandibular angle fractures. Mandibular angle fractures were more frequently caused by immediate external forces, such as an assault or being struck with an object, than were mandibular condyle fractures. Mandibular third molars were seen more frequently in teenage patients and in patients in their twenties than those in their thirties or forties. This probably explains why mandibular angle frac-
tures were more frequent among teenagers or people in their twenties, and why those in their thirties or forties are more vulnerable to a mandibular condyle fracture. Among patients with a mandibular angle fracture, the ratio of mandibular angle fractures was higher when the mandibular third molar was present (1.26 : 1) than when it was absent (0.56 : 1; odds ratio, 6.58), which is a statistically significant finding (P<0.001). Specifically, among patients with a mandibular angle fracture, the ratio of mandibular condyle fractures was 6.58 times higher when a mandibular third molar was present. The ratio of mandibular condyle fractures was lower when the mandibular third molar was present (0.56 : 1) than when it was absent (1.90 : 1; odds ratio, 0.30), which was statistically significant (P<0.001). Specifically, among patients with a mandibular condyle fracture, the ratio of mandibular condyle fractures was 3.37 times higher when a mandibular third molar was absent. When evaluated based on the mandibular third molar position, the ratio of mandibular angle fractures was higher in class II/level B, whereas no significant difference was found for mandibular condyle fractures. Mandibular angle fractures occurred most frequently with horizontal angulation, due to the root development of the mandibular third molar, while mandibular condyle fractures occurred most frequently with a tooth germ as the mandibular third molar. These results demonstrate that both mandibular angle and condyle fractures are significantly affected by the presence of the mandibular third molar and by the continuity of the cortical bone in the mandibular angle.

It is easy to take a therapeutic approach to a mandibular angle fracture, the fragments of which can be effectively reduced. The most frequent complication of a mandibular angle fracture is infection, which is most notable in the mandibular angle. However, this complication can be readily managed by sequestrectomy or, in many cases, by removing the metal plate under local anesthesia. In contrast, oral surgeons agree that a mandibular condyle fracture is substantially more difficult to treat because its poor accessibility makes it hard to remove the fracture fragments and difficult to correctly apply a small metal plate and screws. These difficulties can lead to many complications, including malocclusion, mandibular hypomobility, facial asymmetry, dysfunction or degeneration, and facial nerve damage. A mandibular condyle fracture is more severe, is more difficult to treat, and leads to complications that last longer than a mandibular angle fracture. Thus, it seems unreasonable to suggest preventive removal of the mandibular third molar with the objective of reducing the likelihood of mandibular angle fractures.

Further research will be needed to more comprehensively examine the bone quality of the mandible, the presence and eruption of the mandibular third molar, the direction and strength of the external force applied to the mandible, and the relationships between these factors and mandibular angle and condyle fractures.

V. Conclusion

The presence of the mandibular third molar can be a determinant of mandibular angle and condyle fractures. When considering the intentional extraction of an asymptomatic mandibular third molar in young patients, the results of our study should be considered.

Conflict of Interest

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

References

1. Fonseca RJ. Oral and maxillofacial trauma. 4th ed. St. Louis: Elsevier/Saunders; 2013:186.
2. Gassner R, Tuli T, Haehl O, Rudisch A, Ulmer H. Cranio-maxillofacial trauma: a 10 year review of 9,543 cases with 21,067 injuries. J Cranio-maxillofac Surg 2003;31:51-61.
3. Tanaka N, Tomitsuka K, Shionoya K, Andou H, Kimijima Y, Tashiro T, et al. Aetiology of maxillofacial fracture. Br J Oral Maxillofac Surg 1994;32:19-23.
4. Papel ID, Frodel J. Facial plastic and reconstructive surgery. New York: Thieme; 2002:769-90.
5. Rudderman RH, Mullen RL. Biomechanics of the facial skeleton. Clin Plast Surg 1992;19:11-29.
6. Reitzik M, Schmidt E, Butters RG. Yield point of monkey mandible. J Dent Res 1981;60:1993-5.
7. Huelke DF, Patrick LM. Mechanics in the production of mandibular fractures: strain-gauge measurements of impacts to the chin. J Dent Res 1964;43:437-46.
8. Cho SJ, Kim YG. The study on mandibular fracture mechanism using dynamic 3-dimensional finite analysis. J Korean Assoc Maxillofac Plast Reconstr Surg 2002;24:470-81.
9. Olson RA, Fonseca RJ, Zeitler DL, Osbon DB. Fractures of the mandible: a review of 580 cases. J Oral Maxillofac Surg 1982;40:23-8.
10. Ogundare BO, Bonnick A, Bayley N. Pattern of mandibular fractures in an urban major trauma center. J Oral Maxillofac Surg 2003;61:713-8.
11. Saifdar N, Meechan JG. Relationship between fractures of the mandible and the presence and state of eruption of the lower third molar. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995;79:680-4.
12. Tevepaugh DB, Dodson TB. Are mandibular third molars a risk factor for angle fractures? A retrospective cohort study. J Oral Maxillofac Surg 1995;53:646-9.
13. Lee JT, Dodson TB. The effect of mandibular third molar presence and position on the risk of an angle fracture. J Oral Maxillofac Surg 2000;58:394-8.
14. Schwimmer A, Stern R, Kritchman D. Impacted third molars: a contributing factor in mandibular fractures in contact sports. Am J Sports Med 1983;11:262-6.
15. Yamada T, Sawaki Y, Tohnai I, Takeuchi M, Ueda M. A study of sports-related mandibular angle fracture: relation to the position of the third molars. Scand J Med Sci Sports 1998;8:116-9.
16. Meisami T, Sojat A, Sándor GK, Lawrence HP, Clokie CM. Impacted third molars and risk of angle fracture. Int J Oral Maxillofac Surg 2002;31:140-4.
17. Zhu SJ, Choi BH, Kim HJ, Park WS, Huh JY, Jung JH, et al. Relationship between the presence of unerupted mandibular third molars and fractures of the mandibular condyle. Int J Oral Maxillofac Surg 2005;34:382-5.
18. Duan DH, Zhang Y. Does the presence of mandibular third molars increase the risk of angle fracture and simultaneously decrease the risk of condylar fracture? Int J Oral Maxillofac Surg 2008;37:25-8.
19. Inaoka SD, Carneiro SC, Vasconcelos BC, Leal J, Porto GG. Relationship between mandibular fracture and impacted lower third molar. Med Oral Patol Oral Cir Bucal 2009;14:E349-54.
20. Thangavelu A, Yoganandha R, Vaidhyananathan A. Impact of impacted mandibular third molars in mandibular angle and condylar fractures. Int J Oral Maxillofac Surg 2010;39:136-9.
21. Kelly DE, Harrigan WF. A survey of facial fractures: Bellevue Hospital, 1948-1974. J Oral Surg 1975;33:146-9.
22. Pell G, Gregory BT. Impacted mandibular third molars: classification and modified techniques for removal. Dent Dig 1933;39:330.
23. Shiller WR. Positional changes in mesio-angular impacted mandibular third molars during a year. J Am Dent Assoc 1979;99:460-4.
24. Ellis E 3rd, Moos KF, el-Attar A. Ten years of mandibular fractures: an analysis of 2,137 cases. Oral Surg Oral Med Oral Pathol 1985;59:120-9.
25. Chidzonga MM. Mandibular fractures, analysis of 541 cases. Cent Afr J Med 1990;36:97-103.
26. Cho SP, Lee IH, Kim CH. The influence of mandibular third molar on mandibular angle fracture. J Korean Assoc Maxillofac Plast Reconstr Surg 2006;28:49-57.
27. Bezerra TP, Silva Junior FI, Scarparo HC, Costa FW, Studart-Soares EC. Do erupted third molars weaken the mandibular angle after trauma to the chin region? A 3D finite element study. Int J Oral Maxillofac Surg 2013;42:474-80.
28. Iida S, Hassfeld S, Reuther T, Nomura K, Mühling J. Relationship between the risk of mandibular angle fractures and the status of incompletely erupted mandibular third molars. J Cranio maxillofac Surg 2005;33:158-63.
29. Fuselier JC, Ellis EE 3rd, Dodson TB. Do mandibular third molars alter the risk of angle fracture? J Oral Maxillofac Surg 2002;60:514-8.
30. Kober C, Sader R, Thiele H, Bauer HJ, Zeilhofer HF, Hoffmann KH, et al. Stress analysis of the human mandible in standard trauma situations with numerical simulation. Mund Kiefer Gesichtschir 2001;5:114-9.
31. Lamphier J, Ziccardi V, Ruvo A, Janel M. Complications of mandibular fractures in an urban teaching center. J Oral Maxillofac Surg 2003;61:745-9.
32. Feller KU, Schneider M, Hlawitschka M, Pfeifer G, Lauer G, Eckelt U. Analysis of complications in fractures of the mandibular angle--a study with finite element computation and evaluation of data of 277 patients. J Craniomaxillofac Surg 2003;31:290-5.
33. Zide MF, Kent JN. Indications for open reduction of mandibular condyle fractures. J Oral Maxillofac Surg 1983;41:89-98.
34. Haug RH, Peterson GP, Goltz M. A biomechanical evaluation of mandibular condyle fracture plating techniques. J Oral Maxillofac Surg 2002;60:73-80.
35. Ellis E 3rd. Complications of mandibular condyle fractures. Int J Oral Maxillofac Surg 1998;27:255-7.