Anatomical and Functional Recovery of Intracapsular Fractures of the Mandibular Condyle: Analysis of 124 Cases after Closed Treatment

Jong-Sung Lee, Eun-Gyu Jeon, Guk-Jin Seol, So-Young Choi, Jin-Wook Kim, Tae-Geon Kwon, Jun-Young Paeng

Department of Oral and Maxillofacial Surgery, School of Dentistry, Kyungpook National University

Abstract

Purpose: The purpose of this study is to evaluate the influence of intracapsular fracture lines of the mandibular condyle on the anatomical and functional recovery after non-surgical closed treatment.

Methods: Clinical and radiological follow-up of 124 patients with intracapsular fractures of the mandibular condyle was performed after closed treatment between 2005 and 2012. The intracapsular fractures were classified into three categories: type A (medial condylar pole fracture), type B (lateral condylar pole fracture with loss of vertical height) and type M (multiple fragments or comminuted fracture).

Results: By radiological finding, fracture types B and M lost up to 24% vertical height of the mandibular condyle compared to the height on the opposite side. In Type M, moderate to severe dysfunction was observed in 33% of the cases. Bilateral fractures were significantly associated with the risk of temporomandibular joint (TMJ) dysfunction in fracture types A and B. Bilateral fracture and TMJ dysfunction were not statistically significantly associated in type M fractures.

Conclusion: Most of the mandibular intracapsular condylar fractures recovered acceptably after conservative non-surgical treatment with functional rehabilitation, even with some anatomical shortening of the condylar height. The poor functional recovery encountered in type M fractures, especially in cases with additional fracture sites and bilateral fractures, points up the limitation of closed treatment in such cases.

Key words: Temporomandibular joint disorders, Mandibular fracture, Mandibular condyle

Introduction

Among facial bone fractures, mandible and nasal bone fractures are most common, and condylar fractures are one of the most common fractures in the mandible[1]. Condylar fractures account for 29% to 40% of facial bone fractures and 9% to 62% of all mandible fractures[2-8]. Intracapsular condylar fractures, however, are relatively rare[9].

The ideal approach for diagnosis and treatment of mandibular condylar fractures is an open question. Many studies have investigated treatment methods and physical therapy based on condylar fracture classification[10-12].
indications for closed versus open treatment are also a matter of debate,[13-16], with various methods of conservative treatment reported.[17]. The typical closed treatment is intermaxillary fixation for one or two weeks to correct occlusion and stretch the jaw to prevent ankylosis.[18]. Conservative treatments are preferred to avoid facial nerve injury, scar formation during surgery, and the difficulty of reducing small fragments.[19]. However, several studies observed unpredictable results after conservative treatment, including deviation of the mandible,[17], growth disturbance of the jaw, and ankylosis.[19-21].

The purpose of this retrospective study is to evaluate the influence of intracapsular fracture lines of the mandibular condyle on the anatomical and functional recovery after non-surgical closed treatment.

Materials and Methods

1. Patients

In the period from 2005 to 2012, 180 patients with intracapsular fractures of the mandibular condyle were treated at our institution. In the current study, 124 of these patients (90 male and 34 female patients; average age, 35.4 years; range, five to 71 years) were examined two to 90 months after treatment (mean, 31.2 months). The condylar fractures were caused by slips (n=58), traffic accidents (n=50), falls (n=24), motorcycle accidents (n=20), syncope (n=6), bicycle accidents (n=11), drunkenness (n=9), work accidents (n=6), sports (n=3), and assaults (n=1). The fractures were classified based on radiographs including a panoramic and a postero-anterior radiogram, coronal computed tomography.

The current study adopted Hlawitschka classification system,[22,23], which groups intracapsular fractures into three categories: type A (medial condylar pole fracture), type B (lateral condylar pole fracture with loss of vertical height) and type M (multiple fragments or comminuted fracture) (Fig. 1). Based upon Hlawitschka classification, 29 type A intracapsular fractures, 56 type B intracapsular fractures and 39 type M intracapsular fractures were diagnosed in the present study. Concomitant fractures at other sites of the mandible were treated by osteosynthesis, allowing the initiation of mouth-opening exercises as soon as possible. Closed treatment included one week of intermaxillary fixation and functional observation for four to eight weeks. This study was approved by the institutional review board of Kyungpook National University Hospital (IRB No. 2014-01-002-003).

2. Post-treatment examinations

The clinical findings are summarized using the dysfunction index provided by Helkimo,[24], composed of five criteria: mandibular mobility, temporomandibular joint (TMJ) function, pain in masticatory muscle, TMJ pain, and pain during movement (Table 1). The radiologic examination included orthopantomograph. The distances measured are shown in Fig. 2. Reductions in the height of the ramus and condyle on panoramic radiographs after unilateral condyle fracture were determined by comparison with the height on the non-fractured contralateral side.
Table 1. TMJ clinical dysfunction index (Di) by Helkimo categories[24]

| Symptom                       | Criteria (point)                                                                 |
|-------------------------------|---------------------------------------------------------------------------------|
| Impaired range of movement/mobility index | Normal range of movement (0)                                                    |
|                               | Slightly impaired mobility (1)                                                  |
|                               | Severely impaired mobility (5)                                                  |
| Impaired TMJ function         | Smooth movement without TMJ sounds and/or deviation of ≤2 mm on opening or closing (0) |
|                               | TMJ sounds in one or both joints and/or deviation of ≥2 mm on opening or closing (1) |
| Muscle pain                   | Locking and/or luxation of the TMJ (5)                                          |
| TMJ pain                      | No tenderness on palpation of the masticatory muscles (0)                       |
|                               | Tenderness on palpation of 1~3 palpation sites (1)                             |
| Pain on movement of the mandible | Tenderness on palpation of 4 or more palpation sites (5)                        |
|                               | No pain on movement (0)                                                         |
|                               | Pain on 1 type of movement (1)                                                  |
|                               | Pain on 2 or more types of movements (5)                                        |

Dysfunction score: sum of 5 symptoms (0~25 points), Di0: clinically symptom free (0 point), DiI: mild dysfunction (1~4 points), DiII: moderate dysfunction (5~9 points), DiIII: severe dysfunction (10~25 points).

TMJ, temporomandibular joint.

Table 2. Distribution of loss in ramus and condyle height by fracture type

| Type      | No. of patients | Loss in vertical ramus height (%) | Loss in condyle height (%) |
|-----------|-----------------|-----------------------------------|----------------------------|
| Type A    | 19              | 2.7±2.5                           | 8.3±7.0                    |
| Type B    | 41              | 9.3±4.5                           | 23.7±13.5                  |
| Type M    | 19              | 7.7±5.0                           | 24.0±7.7                   |

Values are presented as number or mean±standard deviation.

Type A, medial condylar pole fracture; Type B, lateral condylar pole fracture with loss of vertical height; Type M, multiple fragments or comminuted fracture.

3. Statistical analysis

The average values and standard deviations were determined using the program Microsoft Excel 2010 (Microsoft, Redmond, WA, USA). Fisher exact test and Cochran-Mantel-Haenszel test were used to determine the significance of differences between types of intracapsular fracture and the presence of additional mandibular fractures. Null hypotheses of no difference were rejected if P-values were less than 0.05, or equivalently, if the 95% confidence intervals of risk point estimates excluded 1.

Results

1. Radiological findings

Radiological evaluation showed a reduction of 24% in the condylar height for intracapsular fracture types B and M and a reduction of 8% for type A fractures, in comparison with the heights on the non-fractured contralateral side. The mandibular ramus height was reduced by an average of 9% for type B, 8% for type M, and 3% for type A (Table 2).

2. Clinical findings

Moderate-to-severe dysfunction was observed in 13 out of 39 type M cases (33.3%), four out of 29 type A cases (13.8%), and six out of 56 type B cases (10.7%). The differences in the risk of moderate-to-severe dysfunction among the three groups were statistically significant (Table 3, Fig. 3; Fisher exact test, P=0.019). Bilateral fractures were significantly associated with the risk of TMJ dysfunction in types A and B fractures. No statistically significant differ-
Table 3. Distribution of clinical dysfunction by fracture type

| Type   | Uni/Bi | No. of patients | Helkimo clinical dysfunction index | Odds ratio | P-value |
|--------|--------|-----------------|------------------------------------|------------|---------|
|        |        |                 | Di0 (n)   | DiI (n)   | Di0+DiI (n) | DiII (n) | DiIII (n) | DiII+DiIII (n) |
| Type A | Uni    | 19              | 9         | 10        | 19          | 0        | 0         | 0             | Inf*         | <0.01   |
|        | Bi     | 10              | 1         | 5         | 6           | 0        | 4         | 4             |             |         |
|        | Sub    | 29              | 10        | 15        | 25          | 0        | 4         | 4             |             |         |
| Type B | Uni    | 41              | 10        | 29        | 39          | 0        | 2         | 2             | 6.78*       | 0.0382  |
|        | Bi     | 15              | 1         | 10        | 11          | 2        | 2         | 2             |             |         |
|        | Sub    | 56              | 11        | 39        | 50          | 2        | 4         | 6             |             |         |
| Type M | Uni    | 19              | 3         | 12        | 15          | 3        | 1         | 4             | 2.979*      | 0.176   |
|        | Bi     | 20              | 2         | 9         | 11          | 2        | 7         | 9             |             |         |
|        | Sub    | 39              | 5         | 21        | 26          | 5        | 8         | 13            |             |         |
| Total  |        | 124             | 26        | 75        | 101         | 7        | 16        | 23            | 5.83†       | <0.01   |

Dysfunction score: sum of 5 symptoms (0–25 points), Di0: clinically symptom free (0 point), DiI: mild dysfunction (1–4 points), DiII: moderate dysfunction (5–9 points), DiIII: severe dysfunction (10–25 points). Type A, medial condylar pole fracture; Type B, lateral condylar pole fracture with loss of vertical height; Type M, multiple fragments or comminuted fracture; Uni, unilateral fracture; Bi, bilateral fracture; Sub, subtotal; Inf, infinity.

*Fisher’s exact test. †Cochran-Mantel-Haenszel test.

Fig. 3. Distribution of clinical dysfunction by fracture type.
Dysfunction score: sum of 5 symptoms (0–25 points), Di0: clinically symptom free (0 point), DiI: mild dysfunction (1–4 points), DiII: moderate dysfunction (5–9 points), DiIII: severe dysfunction (10–25 points). Type A, medial condylar pole fracture; Type B, lateral condylar pole fracture with loss of vertical height; Type M, multiple fragments or comminuted fracture.

Fig. 4. Distribution of clinical dysfunction by fracture type in unilateral fracture. Dysfunction score: sum of 5 symptoms (0–25 points), Di0: clinically symptom free (0 point), DiI: mild dysfunction (1–4 points), DiII: moderate dysfunction (5–9 points), DiIII: severe dysfunction (10–25 points). Type A, medial condylar pole fracture; Type B, lateral condylar pole fracture with loss of vertical height; Type M, multiple fragments or comminuted fracture.

Table 4. Distribution of clinical dysfunction by unilateral/bilateral fracture

| Type   | No. of patients | Helkimo dysfunction index |
|--------|-----------------|---------------------------|
|        |                 | Symptom-free: Di0 (n)    | Mild: DiI (n) | Moderate: DiII (n) | Severe: DiIII (n) |
| Unilateral | 79              | 22                        | 51           | 3             | 3             |
| Bilateral  | 45              | 4                         | 24           | 4             | 13            |
| Total     | 124             | 26                        | 77           | 7             | 16            |

ence was observed in the association between bilateral fractures and TMJ dysfunction in type M cases (Table 3).

Moderate-to-severe dysfunction was observed in 17 out of 45 bilateral fracture cases (37.8%), and in six out of 79 unilateral fracture cases (7.6%). The difference in the number of cases of moderate-to-severe dysfunction between the groups was statistically significant (Table 4, Fig. 3, 4; Fisher exact test, P<0.0001). Moderate-to-severe dysfunction was observed in 20 out of 75 cases with additional fractures (26.7%), and in three out of 49 cases without additional fractures (6.1%). The difference between groups was statistically significant (Table 5; Fisher exact test,
Discussion

The most common causes of condyle fractures cited in the literature are traffic accidents, followed by falls and assaults[25]. Condylar fractures can be caused by indirect forces delivered to the condyle from the direct trauma site[26]. In the present study, the most common cause of an intracapsular condyle fracture was a slip. Condylar fractures may lead to severe problems such as malocclusion, facial growth disturbance, or disorders of the TMJ[27].

Zachariades et al.[26] reported that choice of treatment for condylar fractures depends on factors such as co-morbidity with other facial fractures, the location of condylar fractures, the level of displacement, the state of dentition and dental occlusion, and general condition.

Treatment for condyle fractures includes closed treatment and surgical intervention. Closed treatment includes intermaxillary mobilization and functional therapy. Surgical intervention is used to reposition and stabilize the fragments[8].

Closed treatment is indicated in almost all condylar fractures occurring in childhood[28], because it achieves early mobilization and adequate functional stimulation of con-

![Fig. 5. Distribution of clinical dysfunction by fracture type in bilateral fracture. Dysfunction score: sum of 5 symptoms (0~25 points), Di0: clinically symptom free (0 point), DiI: mild dysfunction (1~4 points), DiII: moderate dysfunction (5~9 points), DiIII: severe dysfunction (10~25 points). Type A, medial condylar pole fracture; Type B, lateral condylar pole fracture with loss of vertical height; Type M, multiple fragments or comminuted fracture.](image)

![Fig. 6. Radiologic findings of patient with bilateral and additional fracture who had severe dysfunction. (A) First visit. (B) Four years later.](image)
dylar growth[8,28]. Conversely, surgical intervention is indicated when the condylar head is severely displaced or dislocated, especially in adults[26,28].

In childhood, remodeling of the mandibular condyle can often recover normal to near-normal morphology and function, since the remodeling center is the mandibular condyle and it responds to changes in the relationship of surrounding structures during growth[29-31].

Conservative treatment may be regarded as the first choice of treatment for fractures of mandibular condyle to avoid nerve injury and scar formation[19]. Nevertheless, contraindications for closed treatment for condylar fractures should be considered carefully. Ellis et al.[32] reported that more severe problems can occur, for example malocclusion and open bite, or deviation on mouth opening, when condylar fractures are treated by closed treatment. Dahlström et al.[29] reported that mild clinical dysfunction can occur after moderate displacement of the condylar head, and moderate clinical dysfunction may occur after condylar head dislocation. Silvennoinen et al.[27] reported that injuries were more often severe after bilateral condylar fractures, compared with unilateral condylar fracture cases.

In this study, type M cases involving bilateral fractures and additional fractures often developed moderate-to-severe dysfunction and deranged condylar morphology (Fig. 6). Bilateral fractures developed more severe functional disturbance than unilateral fractures (odds ratio=5.83, P<0.01; Table 3), although the frequency of dysfunction did not differ between bilateral and unilateral fractures in type M cases. This means that a type M presentation leads to significantly more dysfunction. Type M cases frequently developed severe functional problems even in unilateral cases.

Conclusion

Most mandibular intracapsular condylar fractures showed clinically acceptable recovery with conservative non-surgical treatment and functional rehabilitation even with some anatomical shortening of the condylar height. The poor functional recovery encountered in type M fractures, especially in cases with additional fracture sites and bilateral fractures, point up the limitations of closed treatment for such cases.

References

1. Turvey TA. Midfacial fractures: a retrospective analysis of 593 cases. J Oral Surg 1977;35:887-91.
2. Schuchardt K, Metz HJ. Injuries of the facial skeleton. Mod Trends Plast Surg 1966;2:62-107.
3. Tassinari A, Lamberg MA. Transosseous wiring in the treatment of condylar fractures of the mandible. J Maxillofac Surg 1976;4:200-6.
4. 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.
5. Fridrich KL, Pena-Velasco G, Olson RA. Changing trends with mandibular fractures: a review of 1,067 cases. J Oral Maxillofac Surg 1992;50:586-9.
6. Buchbinder D. Treatment of fractures of the edentulous mandible, 1943 to 1993: a review of the literature. J Oral Maxillofac Surg 1993;51:1174-80.
7. Schün R, Roveda SI, Carter B. Mandibular fractures in Townsville, Australia: incidence, aetiology and treatment using the 2.0 AO/ASIF miniplate system. Br J Oral Maxillofac Surg 2001;39:145-8.
8. Vallati R, Ibrahim D, Abreu ME, et al. The treatment of condylar fractures: to open or not to open? A critical review of this controversy. Int J Med Sci 2008;5:313-8.
9. Rowe NL, Killey HC, editors. Fractures of the facial skeleton. 2nd ed. Edinburgh: E & S Livingstone: 1970. p.2-144.
10. Spiessl B. Rigid internal fixation of fractures of the lower jaw. Reconstr Surg Traumatol 1972;13:124-40.
11. Yamaoka M, Furusawa K, Iguchi K, Tanaka M, Okuda D. The assessment of fracture of the mandibular condyle by use of computerized tomography. Incidence of sagittal split fracture, Br J Oral Maxillofac Surg 1994;32:77-9.
12. Choi BH. Magnetic resonance imaging of the temporomandibular joint after functional treatment of bilateral condylar fractures in adults, Int J Oral Maxillofac Surg 1997;26:344-7.
13. Zide MF, Kent JN. Indications for open reduction of mandibular condylar fractures, J Oral Maxillofac Surg 1983;41:89-98.
14. Ellis E 3rd, Dean J. Rigid fixation of mandibular condyle fractures. Oral Surg Oral Med Oral Pathol 1993;76:650-65.
15. Walker RV. Condylar fractures: nonsurgical management. J Oral Maxillofac Surg 1994;52:1185-8.
16. Hall MB. Condylar fractures: surgical management. J Oral Maxillofac Surg 1994;52:1189-92.
17. Narbølt SE, Krishnan V, Sindet-Pedersen S, Jensen I. Pediatric condylar fractures: a long-term follow-up study of 55 patients. Int J Oral Maxillofac Surg 1993;51:1302-10.
18. Kruger GO, editor. Textbook of oral surgery, 4th ed. Saint Louis: Mosby; 1974. p.2-360.
19. Hovinga J, Boering G, Stegenga B. Long-term results of nonsurgical management of condylar fractures in children, Int J Oral Maxillofac Surg 1999;28:429-40.
20. Cascone P, Sassano P, Spallaccia F, Rivaloli A, Di Paolo C. Condylar fractures during growth: follow-up of 16 patients, J Craniofac Surg 1999;10:87-92.
21. Strobl H, Emshoff R, Röthler G. Conservative treatment of unilateral condylar fractures in children: a long-term clinical
and radiologic follow-up of 55 patients, Int J Oral Maxillofac Surg 1999;28:95-8.

22. Neff A, Kolk A, Deppe H, Horch HH, New aspects for indications of surgical management of intra-articular and high temporomandibular dislocation fractures, Mund Kiefer Gesichtschir 1999;3:24-9.

23. Hlawitschka M, Eckelt U, Assessment of patients treated for intracapsular fractures of the mandibular condyle by closed techniques, J Oral Maxillofac Surg 2002;60:784-91; discussion 792.

24. Helkimo M, Studies on function and dysfunction of the masticatory system, II. Index for anamnestic and clinical dysfunction and occlusal state, Sven Tandlak Tidskr 1974;67: 101-21.

25. Adi M, Ogden GR, Chisholm DM, An analysis of mandibular fractures in Dundee, Scotland (1977 to 1985), Br J Oral Maxillofac Surg 1990;28:194-9.

26. Zachariades N, Mezitis M, Mourouzis C, Papadakis D, Spanou A, Fractures of the mandibular condyle: a review of 466 cases, Literature review, reflections on treatment and proposals, J Craniomaxillofac Surg 2006;34:421-32.

27. Silvennoinen U, Lindqvist G, Oikarinen K, Dental injuries in association with mandibular condyle fractures, Endod Dent Traumatol 1993;9:254-9.

28. De Riu G, Gamba U, Anghinoni M, Sesenna E, A comparison of open and closed treatment of condylar fractures: a change in philosophy, Int J Oral Maxillofac Surg 2001;30: 384-9.

29. Dahlström L, Kahlenberg KE, Lindahl L, 15 years follow-up on condylar fractures, Int J Oral Maxillofac Surg 1989;18:18-23.

30. Lindahl L, Condylar fractures of the mandible, IV. Function of the masticatory system, Int J Oral Surg 1977;6:195-203.

31. Ingervall B, Lindahl L, Masticatory muscle function in patients treated for condylar fractures of the mandible, Int J Oral Surg 1980;9:359-66.

32. Ellis E 3rd, Simon P, Throckmorton GS, Occlusal results after open or closed treatment of fractures of the mandibular condylar process, J Oral Maxillofac Surg 2000;58:260-8.