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Prognosis of diacapitular condylar fractures: a multivariate analysis

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Abstract

The choice of treatment for diacapitular condylar fractures remains in dispute among oral and maxillofacial surgeons. A multivariate retrospective study was designed to compare the prognosis after conservative treatment and surgery, and to explore further indications for management. From 1 July 2013 to 30 June 2017, 169 patients with diacapitular condylar fractures were included. Relevant preoperative data were collected, and the prognoses assessed. Three ordinal logistic regression models were constructed to study the factors that affected prognosis, and these showed that all patients treated by open reduction and internal fixation (ORIF) tended to have a better prognosis than those treated with conservative treatment (adult: odds ratio (OR) = 6.166, p = 0.000, and children: OR = 12.195, p = 0.029). Adult patients with lateral dislocation of the stump of the ramus out of the glenoid fossa tended to have the highest risk of a poor prognosis, followed by those with anteromedial displacement of the disc and loss of the height of the ramus of over 5 mm. Only the type of treatment affected the prognosis for children. In conclusion, these findings suggest that ORIF is the preferred method of treatment for patients with diacapitular condylar fractures. The absolute indications for ORIF in adult patients with diacapitular condylar fractures include lateral dislocation of the stump of the ramus out of the glenoid fossa, anteromedial displacement of the disc, and loss of height of the ramus of over 5 mm. There are no absolute indications for ORIF in children.

Keywords: diacapitular condylar fractures; multivariate analysis; ORIF; conservative treatment; indications for treatment

Introduction

Fractures of the mandibular condyle are common, and account for 29%–52% of all mandibular fractures.[1–3] Diacapitular condylar fractures (defined as those in which the fracture line starts in the articular surface and may extend outside the capsule[4]) are the most common in the condylar region.[5,6] Patients usually present with malocclusion, restricted mandibular movement and limited mouth opening, which may lead to poor self-esteem and health problems.[7]

Two methods for managing diacapitular condylar fractures are currently available: surgery and conservative treatment.[8] Before the 1990s, most surgeons favoured conservative treatment because it is easy, while an operation involves negotiating complex anatomical structures in a limited surgical field, with the risk of serious operative complications. Many of the published reports, therefore, are related to conservative rather than surgical treatment,[9,10] although some have described serious complications after conservative treatment, including disorders of the temporomandibular joint (TMJ), asymmetry of the facial contours, and ankylosis of the TMJ.

Improved methods of imaging, instrumentation, and fixation, and the emergence of digital surgical techniques have

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promoted developments in the surgical treatment of diacapitular condylar fractures. Compared with conservative treatment, surgery can not only achieve accurate reduction of fractured fragments, but also add the insurance of an intact TMJ disc to restore the pretraumatic anatomy. It also can promote prompt functional recovery,[11,12] thereby lowering or even eliminating the risk of some complications. Given how few postoperative complications are associated with the operation, surgeons have come to prefer this method for treating these fractures.

Although these two methods are common in clinical practice, the indications for each are still controversial,[13–18] because the prognosis is affected by many interacting factors, which makes the results of related univariate analyses unreliable. Under these circumstances, multivariate analysis about the prognosis is both necessary and important. However, we know of no studies to date that have used multivariate analysis to explore the factors that affect the prognosis of diacapitular condylar fractures, so we organised a multivariate study of 162 patients to compare the prognosis of conservative treatment and surgery, and to explore indications for treatment further.

Patients and methods

Ethics statement

We conducted a hospital-based retrospective study (ChiCTR1800016895) at the Division of Traumatic and Plastic Surgery, Department of Oral and Maxillofacial Surgery at the West China Hospital of Stomatology, Sichuan University from 1 July 2013 to 30 June 2017. The protocol was approved by the Institutional Review Board of Sichuan University (approval number: WCHSIRB-ST-2017-124).

Subjects

The inclusion criteria of the study subjects were as follows: patients diagnosed with diacapitular condylar fractures by clinical, and computed tomographic (CT) and magnetic resonance imaging (MRI); those treated conservatively or surgically; those followed up for at least six months; and those with integrated medical records. Patients were excluded if they had undisplaced fractures; incomplete information; were lost to follow-up; or had had their fractures previously treated surgically at other hospitals.

Design of prognostic evaluation criteria

We designed the prognostic evaluation criteria of diacapitular condylar fractures according to the Helkimo index (Table 1).[19] The prognosis was evaluated using a set of observable variables that included scores for diff ;erent symptoms.

Table 1
Prognostic evaluation criteria for diacapitular condylar fractures.

Variables	Symptoms
Facial contour:	
5	Asymmetry or mandibular retrusion or increase of mandibular width. Loss of the ability to wrinkle the forehead. Loss of the ability to close the eyes.
1	Mild changed of facial contour. Reduced ability to wrinkle the forehead. Reduced ability to close the eyes.
0	No obvious change of facial contour No facial nerve injuries
Function:	
Occlusion	
5	Impossibility of obtaining adequate occlusion and masticatory function.
1	Inadequate restoration of occlusion that has no effect on masticatory function.
0	Adequate occlusion.
Maximum mouth opening:	
5	≤10mm
3	10<Opening≤20
1	20<Opening≤30
0	>30mm
Movement of the jaw:	
5	Limited mobility on 2 or more movements.
1	Limited mobility on 1 movement.
0	Normal range of movement.
Symptom of dysfunction of the temporomandibular joint:	
5	Locking or luxation of joint.
3	Pain on mouth opening.
1	Joint sounds and/or deviation ≥2 mm on opening or closing.
0	Smooth movement without joint sounds and deviation ≤2 mm.

The scores of each patient were used to calculate the level of prognosis as follows: L1 (all scores 0) indicated no clinical symptoms and ideal prognosis; L2 (at least one score = 1 point) indicated mild dysfunction or malformation; L3 (at least one score = 3 points) indicated mid-level prognosis; L4 (at least one score = 5 points) indicated poor prognosis.

Collection of data

Age at the time of injury, loss of height of the ramus, position of the disc, relative positions of the stump of the mandibular ramus and the articular fossa, methods of treatment, and type of fractures according to the Neff classification[20] were collected and standardised by two investigators based on the patients' clinical and radiographic examinations and medical records. Postoperative data on facial contour and function (Table 1) were collected and standardised by the same investigators based on the patients' clinical examinations. The patient's prognosis was evaluated according to the prognostic evaluation criteria.

Patients were classified as adults (older than 18 years) or children (18 and under), and the children were divided into 1–6, 7–12, and 13–18 age groups. As shown in Table 2, the relative positions of the stump of the mandibular ramus and the articular fossa were classified into three types,[21] loss of height of the ramus was classified into three types based on the patients' radiographic examinations,[8] and the position of the disc was classified into two types based on the patients' MRI

Table 2
The assignment of new values to the appropriate variables for adults and children.

Variables	Symptoms
Prognosis (Y):	
1	L4 (poor prognosis).
2	L3 (mid-level prognosis).
3	L2 (mild dysfunction or malformation).
4	L1 (no clinical symptoms and ideal prognosis).
Relative position of the mandibular ramus stump and the articular fossa (X1):	
1	III (the stump of the ramus dislocating laterally out of the glenoid fossa).
2	II (the stump of the ramus dislocating laterally in the glenoid fossa and the vertex of stump contacting with glenoid fossa) L2 (mild dysfunction or malformation).
3	I (the stump of the ramus and in the glenoid fossa and the vertex of stump not contacting with glenoid fossa).
Position of the disc (X2):	
1	II (inferomedial displacement of the disc)
2	I (no displacement of the disc)
Loss of ramus height (X3):	
1	III (the loss was more than 5 mm).
2	II (the loss was less than 5 mm).
3	I (no loss).
Method of treatment (X4):	
1	Conservative treatment.
2	Open reduction and internal fixation.
Age group (X5) (years) :	
1	1-6
2	7-12
3	13-18

The scores of each patient were used to calculate the level of prognosis as follows: L1 (all scores 0) indicated no clinical symptoms and ideal prognosis; L2 (at least one score = 1 point) indicated mild dysfunction or malformation; L3 (at least one score = 3 points) indicated mid-level prognosis; L4 (at least one score = 5 points) indicated poor prognosis.

and CT scans in the coronal planes. Methods of treatment were classified as conservative and surgical (open reduction and internal fixation (ORIF) and removal of the condylar segment).

Study variables and statistical analysis

The data from the clinical examinations were double-checked before being processed in a computer. For statistical analysis we used IBM SPSS Statistics for Windows software (version 21.0; IBM Corp). The data are given as mean (SD). Ordinal logistic regression was used to identify any valuable variables that affected the clinical prognosis, and to control the confounding variables. An odds ratio (OR) greater than one indicated that patients were at risk of a worse prognosis. Probabilities of less than 0.05 were accepted as significant, as were 95% CI of estimates of risk points that excluded one.

We designed three ordinal logistic regression models for adult patients and children, respectively. Table 2 shows the assignment of new values to the appropriate variables.

Table 3
The prognosis for adult and children with diacapitular condyle fractures.

Variable	Prognosis				No.
	L1	L2	L3	L4	
Sex:					
Male	67	46	7	4	124
Female	20	14	3	1	38
Age (years):					
>18	52	34	6	5	97
≤18	35	26	4	0	65
Type:					
A	24	12	3	0	39
B	48	34	5	2	89
C	13	17	1	3	34
Treatment:					
Conservative	64	55	9	4	132
ORIF	23	5	1	1	30

ORIF = open reduction and internal fixation.

Results

A total of 198 patients were diagnosed with diacapitular condylar fractures from 1 July 2013 to 30 June 2017. We omitted 29 patients in accordance with the exclusion criteria. Of the 169 patients who met the inclusion criteria, three patients were treated by removal of the condylar segment, and four with a combination of two different methods. Given that the sample sizes were too small to provide significant comparisons, 162 patients were finally enrolled in the study. There were 124 men and 38 women, mean (SD) age 28 (18) years (range 3-80). There were 52 patients with bilateral, and 110 with unilateral, fractures. Conservative treatment (intermaxillary fixation with screws and elastics) was used for 132 patients. Of those operated on, 9/52 and 21/110 had ORIF with plates and compression screws (Table 3).

Prognosis for adult patients with diacapitular condylar fractures

The results of ordinal logistic regression in 97 adult patients are summarised in Table 4. Patients treated with ORIF (OR = 6.166) tended to have a better prognosis than those treated conservatively (p = 0.000, 95% CI 2.289 to 16.627). The factors affecting prognosis for adult patients were loss of height of the ramus, position of the disc, and the relative position of the stump of the mandibular ramus and the articular fossa. To be specific, patients who had lateral dislocation of the stump out of the glenoid fossa had the highest risk of a bad prognosis (OR = 15.504, P = 0.000), followed by anteromedial displacement of the disc (OR = 4.527, p = 0.006) and loss of height of the ramus of more than 5 mm (OR = 3.155, p = 0.034).

We also studied the prognosis of adult patients who were treated conservatively (Table 5). The above three factors affected the prognosis for adult patients in the conservative group. Patients who sustained lateral dislocation of the stump out of the glenoid fossa had the highest risk of a bad prognosis

Table 4
Evaluation of risk factors of prognosis in adult patients by ordinal logistic regression.

Factors	Variables	p value	OR	95% CI
Threshold:				
Prognosis (1/4)	Y	0.000	12.280	3.532 to 42.649
Prognosis (2/4)		0.000	116.396	27.140 to 499.196
Prognosis (3/4)		0.000	297.080	60.825 to 1449.538
Location:				
Relative position of the stump of the mandibular ramus and the articular fossa (1/3)	X_1	0.000	15.504	5.028 to 47.799
Relative position of the stump of the mandibular ramus and the articular fossa (2/3)		0.353	1.507	0.634 to 3.578
Position of the disc (1/2)	X_2	0.006	4.527	1.551 to 13.210
Loss of ramus height (1/3)	X_3	0.034	3.155	1.089 to 9.134
Loss of ramus height (2/3)		0.826	1.132	0.293 to 2.662
Method of treatments (1/2)	X_4	0.000	6.166	2.289 to 16.627

Table 5
Evaluation of risk factors of prognosis in adult patients by ordinal logistic regression in the conservative group.

Factors	Variables	p value	OR	95% CI
Threshold:				
Prognosis (1/4)		0.034	2.319	1.064 to 5.053
Prognosis (2/4)	Y	0.000	33.248	8.232 to 99.584
Prognosis (3/4)		0.000	122.364	30.417 to 492.257
Location:				
Relative positions of the stump of the mandibular ramus and the articular fossa (1/3) Relative positions of the stump of the mandibular ramus and the articular fossa (2/3)	X_1	0.000 0.276	47.876 1.723	11.370 to 201.140 0.648 to 4.577
Position of the disc (1/2)	X_2	0.004	5.860	1.782 to 19.240
Loss of height of the ramus (1/3)	X_3	0.041	3.575	1.055 to 12.10
Loss of height of the ramus (2/3)		0.818	1.163	0.239 to 3.096

Table 6
Evaluation of risk factors of prognosis in pediatric patients by ordinal logistic regression.

Factors	Variables	p value	OR	95% CI
Threshold:				
Prognosis (1/4)	Y	0.200	2.166	0.664 to 7.071
Prognosis (2/4)		0.000	29.577	7.022 to 124.711
Location:				
Relative position of the stump of themandibular ramus and the articular fossa (1/3)	X_1	0.814	1.179	0.298 to 4.674
Relative position of the stump of the mandibular ramus and the articular fossa (2/3)		0.905	0.941	0.347 to 2.552
Position of the disc (1/2)	X_2	0.689	1.305	0.355 to 4.807
Loss of height of the ramus (1/3)	X_3	0.200	2.683	0.591 to 12.170
Loss of height of the ramus (2/3)	X3	0.299	2.400	0.631 to 9.125
Method of treatments (1/2)	X_4	0.029	12.207	1.285 to 116.048
Age (1/3)	X_5	0.846	0.899	0.305 to 2.643
Age (2/3)		0.295	2.177	0.507 to 9.356

(OR = 47.847, p = 0.000), followed by those with anteromedial displacement of the disc (OR = 5.860, p = 0.004) and those with loss of the height of the ramus of more than 5 mm (OR = 3.575, p = 0.041).

Prognosis for children with diacapitular condylar fractures

The results of ordinal logistic regression of multiple factors in 65 children are summarised in Table 6. Patients treated with ORIF (OR = 12.207) had a better prognosis than those with conservative treatment (p = 0.029, 95%CI 1.285 to 116.048). However, the above three cases were not risk factors that affected their prognosis.

Discussion

There is still much controversy about the effects and choice of treatments in diacapitular condylar fractures. We therefore organised a multivariate study with a large sample to compare the prognoses of conservative treatment and surgery, to explore the factors that affect prognosis further, and to provide a reference for developing therapeutic indications.

Both adults and children treated with ORIF had better functional recovery than those treated conservatively, and there are three reasons that may explain this. Firstly, accurate reduction and stable fixation of fragments are achieved after ORIF, which is beneficial for primary healing, provides early functional recovery, and promotes the recovery of ideal

occlusal relations and facial contours. Secondly, diacapitular condylar fractures are often associated with displacement and tearing of discs. As some published papers have reported, many patients were noted to have disorders of the TMJ after conservative treatment.[13,22,23] In contrast, ORIF guarantees the re-establishment of the pretraumatic anatomical position as well as the anatomical shape of the disc, thereby decreasing the occurrence of TMJ disorders.[15] Thirdly, our results showed a low incidence of surgical complications. Although concern over complications continues to exist, this is not one of the main factors to consider when deciding between open surgical and conservative treatment.

All our operations were done by the same surgical team, and the indications for operation were: the patient gave consent; it was impossible to obtain adequate occlusion by conservative treatment; the presence of lateral extracapsular displacement or displacement into the middle cranial fossa; the presence of disc displacement or tear; and condylar displacement and loss of height of the ramus. As we can see from the indications, the cases treated surgically were more complex than those managed conservatively. The results of prognosis of ORIF and conservative treatment showed that ORIF was ideal.

Some of the patients had unilateral fractures, and some bilateral, which would influence the outcome measures. However, as the results showed, of the 73 patients treated conservatively, 23 were bilateral (less than a third). Of 24 patients treated with ORIF, eight were bilateral (a third). In terms of the proportion of bilateral fractures, more patients were operated on. It was suggested that the surgical cases were more complex than the conservative ones. Theoretically, if the treatment effects in the conservative group were similar with those in the ORIF group, the patients treated with ORIF would have a worse prognosis than those treated with conservative treatment. However, the results showed that the patients treated with ORIF had a better prognosis than those treated conservatively, which confirms that ORIF was the ideal treatment.

We discussed the factors affecting prognosis to establish indications for surgery. For adult patients with diacapitular condylar fractures, there were three factors (other than the type of treatment), including loss of height of the ramus, position of the disc, and the relative position of the stump of the mandibular ramus and the articular fossa. The results showed that patients tended to have a high risk of a poor prognosis when they sustained lateral dislocation of the stump out of the glenoid fossa, anteromedial displacement of the disc, and loss of height of the ramus of more than 5 mm.

Additionally, under similar indications and conditions, adult patients treated conservatively were more likely to have a bad prognosis, and we think that this finding is a result of the following three aspects. First, and most importantly, the anatomical position and shape of the disc can help prevent disorders of the TMJ and decrease the occurrence of ankylosis. Secondly, fractures are always accompanied by the destruction of the bony and cartilaginous surfaces of the condyle, which leads to the fusion of the stump and the zygomatic arch and a high risk of the development of fibrous or bony ankylosis. Thirdly, regaining the pretraumatic anatomical height of the ramus after considerable loss is hard or even impossible through reconstruction of the mandibular condyle alone. Adult patients treated conservatively therefore had a high occurrence of a poor prognosis because of the difficulties of reconstructing the condyle. We suggest that these three conditions should be absolute indications for ORIF.

For children, the results showed that the prognosis was not correlated to the above three factors. One explanation for this may be that children are in a period of growth with excellent reconstructive ability, so they will have a relatively good prognosis with early functional exercises. We suggest therefore that there is no absolute indication for ORIF in children. Given that patients treated with ORIF had better functional recovery than those treated conservatively, ORIF is indicated for diacapitular condylar fractures with displaced fragments and discs in children who seek better functional recovery.

The coefficient of intra-rater reliability was 0.814 (Cronbach's α value), which indicated that the measurements had better reliability. The result of a validity test further clarified that the prognostic evaluation criteria is reasonable and scientific (value of Kaiser-Meyer-Olkin >0.7, $p = 0.032$).

Our results indicated that patients treated with ORIF had a better prognosis than those treated conservatively. Even so, considering this was a retrospective study, a random controlled trial or a multicentre and large sample study is necessary to further verify this conclusion.

In conclusion, our results suggest that ORIF is the preferred method in patients with diacapitular condylar fractures. The absolute indications for ORIF in adults included lateral dislocation of the stump out of the glenoid fossa, anteromedial displacement of the disc, and loss of ramus height of more than 5 mm. There is no absolute indication for ORIF in children.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patients' permission

The protocol, the survey and the consent forms were approved by the Institutional Review Board of Sichuan University and complied with the principles laid down in the Declaration of Helsinki. The patients' permission was not required.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.bjoms.2019.08.025.

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