

Three-dimensional evaluation of healing joint morphology after closed treatment of condylar fractures

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Abstract. Closed treatment for condylar fractures has long been widely accepted. With closed treatment, the deviated bone fragments heal in their new positions, and this may subsequently cause a range of functional impairments. The association between healing morphology and post-treatment functional impairment is unclear. In this study, computed tomography images of 26 patients (35 sides) who had undergone closed treatment for condylar fractures were used to perform a comparative investigation of three-dimensional (3D) bone morphology before and after treatment. As a result, the morphology of the condylar process after treatment was classified into four different patterns: unchanged, spherical, L-shaped, and detached. In terms of the association between fracture types and healing morphology, fractures of the condylar head healed in the spherical pattern, simple fractures of the condylar neck healed in the spherical or L-shaped pattern, and comminuted fractures of the condylar neck healed in the spherical, L-shaped, or detached pattern. The association between mandibular deviation and healing morphology was also investigated, and it was found that deviation was greater for the spherical and detached patterns than for the L-shaped pattern. The present findings indicate that 3D evaluation of the fractured condylar process is required to elucidate the association with functional impairment after healing.

Key words: condylar fracture; closed treatment; three-dimensional evaluation; classification; functional impairment.

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Fractures of the condylar process are common fractures of the mandible, occurring in approximately 25–35% of cases,^{1–3} and their fracture patterns vary.⁴ MacLennan⁵ and Lindahl⁶ described different fracture patterns, and these pattern

differentiations are often used in practice to select the method of treatment. Treatment can broadly be divided into open or closed, but there are no clear criteria to determine the choice between them. Although treatment also depends on the

morphological and functional characteristics of the temporomandibular joint (TMJ), the treatment strategy decision is affected by many factors, including the fracture site and pattern, as well as patient-related factors.

Closed treatment, chosen particularly for intracapsular or complex fractures, is a minimally invasive method of treatment. This involves the use of intermaxillary fixation or restrictions of jaw movement, which encourages healing by keeping the mandible still. However, if the jaw is immobilized while the condyle is still dislocated or deviated, the joint will be a different shape after it has healed. Persistent sequelae due to changes in bone morphology, such as trismus, mandibular deviation, and malocclusion, are not uncommon with this method, which may also cause TMJ disorders and pseudarthrosis over the long term.^{7,8}

In this study, the types of morphology seen in healed bone after various fracture patterns were investigated and classified, with the aim of enabling the prediction of post-healing functional impairment on the basis of fracture site and pattern. Using three-dimensional computed tomography (3D-CT) images to carry out a three-dimensional (3D) rather than a conventional two-dimensional (2D) evaluation, the healing morphology of the condylar process after closed treatment could be classified into four patterns. A further investigation into the association of these four patterns with post-healing functional impairment was also performed.

Materials and methods

A retrospective study was conducted of 26 patients (16 men, 10 women) who attended the department of oral and maxillofacial surgery of the study hospital between January 2010 and December 2014. These patients were diagnosed with a fracture of the condylar process and were treated conservatively. Those with a temporomandibular disorder, facial bone fracture, or who had undergone previous orthognathic surgery were excluded from the study, as were symptomatic patients. The fracture site was on the right in seven cases, the left in 10, and on both sides in nine, for a total of 35 sides. Age at the time of injury ranged from 17 to 86 years (mean 48.6 years). The causes of injury included traffic accidents, falls, sports, and quarrels.

Conservative treatment

The basic treatment was intermaxillary fixation with elastic or wire for approximately 2 weeks, using either an intramaxillary splint or existing dentures. However, elderly patients (>80 years old) either used a chin cap or were instructed to consume a soft diet. Active mouth-opening exercises were encouraged soon after the intermaxillary fixation was released.

Assessment method

With each patient's consent, CT images were obtained at the time of injury and at 1 year post-treatment. These were converted to 3D-CT images using an AZE Virtual-Place medical image analysis workstation (AZE, Tokyo, Japan). The 3D-CT images produced were trimmed using the workstation software to ensure that the condylar process, coronoid process, and mandibular ramus were clearly visible.

A post-healing functional assessment, with the patient in the seated position, was performed at 1 year after treatment during an outpatient visit. The patient was asked to open and close the lower jaw by him/herself, and the deviation of the mandibular midline was checked.

Results

Fracture pattern at the time of injury

CT images scanned at the time of injury were used to produce 3D-CT images. Fractures were categorized into three types according to the MacLennan classification,⁵ depending on whether the fracture site was in the condylar head (three sides), the condylar neck (24 sides), or the condylar base (eight sides).

The great majority of fractures of the condylar head involved deviation or dislocation of small bone fragments. Fractures of the condylar neck were categorized as simple fractures with a single fracture line (nine sides) or comminuted fractures with multiple fracture lines (15 sides). Small bone fragments were deviated or dislocated medially in all cases in which the fracture was located in the condylar neck. The fractures on eight sides

categorized as fractures of the condylar base showed clear fracture lines but no deviation of the bone fragments.

Classification of healing morphology

The 3D-CT images from 1 year after treatment were used to classify the morphology of the condylar process into four different patterns: unchanged, spherical pattern, L-shaped pattern, and detached pattern. If there was no evident change in morphology on 3D images before and after treatment, the pattern was classified as unchanged (Fig. 1). Cases in which small bone fragments had been deviated or dislocated medially and had fused with the fractured end of the ramus in that position, healing in a spherical shape, were classified as spherical pattern (Fig. 2). Cases of simple fracture of the condylar neck in which a small bone fragment had been pulled by the lateral pterygoid muscle so that it tilted sideways in a medial direction, in which position fusion occurred at its point of contact with the fractured end of the ramus in the shape of an L, were classified as L-shaped pattern (Fig. 3). Cases of comminuted fracture of the condylar neck in which most of the crushed small bone fragments had fused, but one or more fragments remained individually detached, were classified as detached pattern (Fig. 4).

Association between fracture pattern at the time of injury and morphology after healing

The association between the fracture pattern at the time of injury and bone morphology after healing is shown in Fig. 5. The morphology of the condylar process

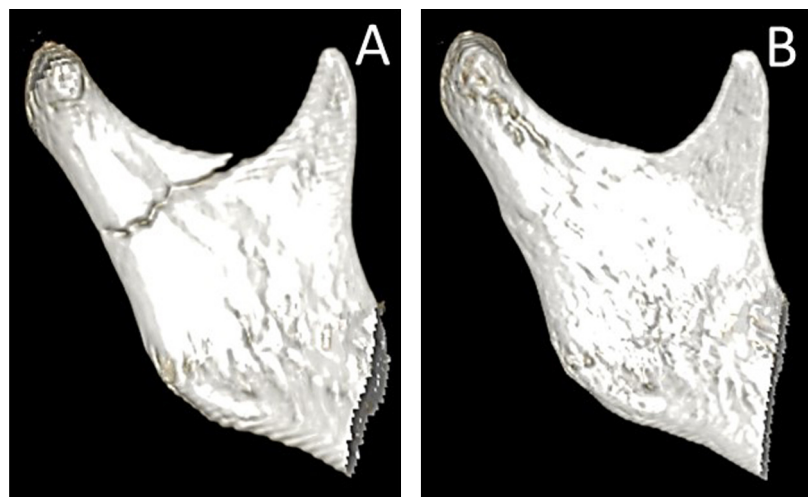


Fig. 1. Unchanged. If there was no evident change in morphology on three-dimensional images obtained before (A) and after (B) treatment, the pattern was classified as unchanged.

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