

Clinical and Histological Experimental Investigation of Temporomandibular Joint Traumatic Arthritis

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Abstract: Objective: To investigate the symptoms and pathology related to classification of temporomandibular joint traumatic arthritis (TMJTA) and the use of classification of various forms. Methods: The clinical and imaging data of 41 patients with TMJTA caused by joint blunt trauma, 32 patients with chronic TMJTA caused by condylar fractures and 6 patients with a long time opening limitation after condylar fractures were included in the present study. In addition, the pathology of an experimental rabbit model of traumatic arthritis model of rabbit was examined and investigated pathologically. Results: Joint movement restriction was found in most patients with TMJTA. The imaging results findings revealed were bony degenerative changes, disc displacement, and joint adhesion in the patients with TMJTA caused by blunt trauma and condylar deformity in the patients with TMJTA caused by condylar fractures. In the experimental rabbits, hemorrhages, and condylar and disc damage could be seen in the early stage and signs of repair were seen repairing action in the later stage of acute trauma. Conclusion: The causes of TMJTA can be classified into two types: which was caused by joint blunt trauma and condylar fractures. The time boundary of acute and chronic TMJTA caused by blunt trauma and TMJTA caused by condyle fractures was suggested as one and six months respectively. The time boundary of acute and chronic TMJTA caused by blunt trauma and TMJTA caused by condylar fractures was suggested as one month and half a year respectively.

Key words: temporomandibular joint traumatic arthritis, acute blunt trauma, condyle fractures, joint adhesion

Introduction

Traumatic arthritis or post-traumatic arthritis is mostly generally referred to as traumatic osteoarthritis or arthritis induced by trauma¹⁻³⁾. Although temporomandibular joint traumatic arthritis (TMJTA) is a frequently occurring form of arthritis, however, though frequently happened, research on the subject is relatively sparse. There is still no consensus on the concept up to date. There has been so few literature on the study of TMJTA that its clinical features, developmental regularity, treatment and prevention of TMJTA are not well documented. It is therefore necessary to clarify the concept and explore the clinical features and development regularity of TMJTA.

In this study, TMJTA's clinical features were studied through analyzing the patients' symptoms, signs and MRI, and radiographic and arthrographic imaging data. An animal model was used to observe the acute TMJ trauma's histological manifestations and progression. In patients with long-term time opening limitation after condyle fractures, the TMJ's adhesive tissue was surgically excised and examined histologically.

Materials and Methods

Patients

Included in the study were forty-one patients (21 males and 20 females, ages between 11-53 years, with a mean age of 32.27) with TMJTA resulting from TMJ blunt trauma (TMJTA-BT, the soft and hard tissue of TMJ were contused without condyle fracture), 32 patients (19 males and 13 females, ages between 11-56 years, mean age, 30.50) with chronic TMJTA resulting

from condyle fractures (TMJTA-CF) and 6 patients (3 males and 3 females, ages between 18-31 years, mean age, 23.17) with long time opening limitation after condyle fractures were included in this study. The TMJTA-BT patients admission criteria were that all the patients had suffered from TMJ blunt trauma and at least one of the following three symptoms: click, pain or opening limitation after trauma. None had a history of temporomandibular disorders (TMD). The chronic TMJTA-CF patients admission criteria were that the symptoms and signs of opening limitation, joint and/or muscle pain and TMJ click and locking lasted at least six months, half a year with or without treatment with or without treatment and with no TMD history. No patients from either group had a history of temporomandibular disorders (TMD). The admission criteria for patients with long-term time opening limitations after condyle fracture were that the opening limitation of less than or equal to 30 mm lasted at least 2 months after condyle fracture, with or without treatment. However, one patient with an opening limitation of only 5 mm opening lasting for a month was also included.

All the patients in this study were acquired from the Center for Temporomandibular Disorders and Orofacial Pain, and the Center for Traumatology, Peking University School of Stomatology. Study protocol

The symptoms and radiograph, arthrograph and MRI data were recorded immediately after trauma, treatment plan, and the symptoms progress of throughout the progression of the TMJTA-BT and chronic TMJTA-CF patients were routinely recorded and the TMJ imaging data was also collected, including radiographs, arthrographs and MRI. Then, a specific diagnosis was made according to Xuchen Ma and Zhengkang Zhang's TMD classification⁴⁾. All the patients with long-term opening

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limitations were treated with surgery (4 with open surgery of arthroplasty surgery, 2 with arthroscopic surgery of arthrolysis and arthrolavage), and the adhesion tissue was excised during open surgery and investigated histologically.

Animal Experimental design

Fifteen oryctolagus cuniculus rabbits (seven females and eight males) weighing 2.0kg-2.5 kg were used. They were fed a with high- quality laboratory practice diet in pellets provided by the Animal Study Center of Peking University Health Center . Rabbits were maintained under natural light and dark cycles and allowed free access to food and water. Experiments were performed in accordance with the institutional ethical guidelines. All the animals had nowere free of teeth deformities orand occlusion disorders.

A striking instrument was designed by reference to as decribed by Luz's study⁵⁾. It which was constructed by a scaffoldusing, a metallic mass weighing 1.0 kg, a columned, wooden block (diameter 2.8 cm) and two cuboid wooden blocks (12 cm x10 cm x 1.5 cm) fixed on athe scaffold, to maintain the head position (Figure 1). Under general anesthesia with Ketamine (1 mg/ per kilogram) and amobarbital sodium amobarbital (3 mg/ per kilogram), the rabbit was placed in dorsal-decubitus with the head in between the two wood blocks to ensure the line of central points of mandible angle and condyle to be vertical and against the central point of the columned wooden block and the metallic mass. The trauma-inducing procedure was done as follows: the metallic mass was elevated 25 cm high and released with free fall to strike the columned wooden block at the end. The kinetic energy (2.45 J, assuming no loss of energy) was transferred to the joint, causingand caused a trauma (all the kinetic energy was supposed to be transferred without loss).

Fifteen rabbits were randomly divided into five groups with three in each group. The right TMJ was used as the experimental side and the left one was used as the control side. After trauma, the animals in different groups were killed in 24 hours, 1 week, 2 weeks, 1 month or two months after the traumain sequence. Both sides' joints were removed on both sides.

Histological study

TMJ tissues removed from rabbits and patients with long-timerm opening limitations after condyle fracture was fixed in 10% neutralized formaldehyde for 24 hours, decalcified with compound acid (40% formyl, 10% formaldehyde, 5% Acetic acid, 5% hydrochloride, 40% distilled water), dehydrated in by ethanol, and embedded in paraffin. Half serial 5 μm tissue sections were made and stained with hematoxylin and eosin. These sections were

observed under a light microscope (Olympus BX51, Olympus Japan).

Results

Clinical study and histological data

Joint movement restriction was found in 23 cases of TMJTA-BT patients. The opening range was 12-35 mm with a, mean of 26.5 mm. Of the 23 cases, 13 were accompanied with joint pain, 2 with a click, 4 with joint pain and a click, and 4 had no concomitant symptoms. Ten cases of them patients also had masticatory muscle pain; 3 cases complained of difficulty in chewing; 3 cases had ipsilateral headaches; and one case suffered from hearing disturbances and tinnitus.

Osteoarthritis changes were found in 19 out of 41 cases (19/ 41), of which, flattening and/or sclerosis of the condylar anterior slope could be seen in 7 cases; erosion of the condylar anterior slope and/or the eminence in 6 cases; osteophyte of the condyle in 4 cases and shortening and flattening of the condyle in 2 cases. Thirty cases (30/41) totally had a totallyn abnormal joint space. Arthrogram (13 cases, 18 joints) and MRI (7 cases, 14 joints) findings were showed onare shown in table 1. The diagnoses for the TMJTA-BT patients are shown innts were showed on table 2.

For the TMJTA-CF patients, joint movement restriction was found in 23 cases (opening range 19-35 mm, mean 28 mm), 18 cases of which were accompanied with joint pain. Joint click (without joint movement restriction or joint pain) was found in 7 patients and joint pain (without joint movement restriction or joint click) was found in 2 patients. There were totally 12 out of the 32 patients, 7 accompanied with suffered chewing impotence (7 cases) and 5 suffered from or pain of masticatory, jugular or shoulder muscles (5 cases), etc.

X-ray examination showed that there were 22 cases with unilateral and 10 cases with bilateral condyle fractures. Of the 22 cases with unilateral fractures, 1 case was an intracapsular fracture, 11 cases were condyle neck fractures, 6 cases were sagittal and 4 cases were condyle base fractures. The displacements and healing deformity of the fracture fragments could be seen. In addition, progressive osteoarthritis changes in contra-lateral joints could be seen in 5 of 22 cases with unilateral condyle fractures. Of the 10 cases with bilateral fractures, there were 7 cases with bilateral condyle neck fractures, 2 cases with condyle neck fractures in one side and condyle base fractures in the contra-lateral side, and 1 case with a condyle neck fracture in one joint and an intracapsular condyle fracture in the joint on the other side. The displacements and healing deformities of the condyle fractures could be seen.

Table 1 Arthrographic and MRI findings in 20 cases

Arthrogram and MRI	Cases
unilateral anterior disk displacement with reduction	4
bilateral anterior disk displacement with reduction	1
anterior disk displacement with reduction in one side and without reduction in another side	1
unilateral anterior disk displacement without reduction	4
unilateral anterior disk displacement without reduction but with disk perforation	1
unilateral disk perforation	2
bilateral disk perforation	1
disk perforation in one side, anterior disk displacement with reduction in another side	1
adhesion in upper joint cavity	2
normal disk position	2
medial and lateral pterygoid muscle edema	1
total	20

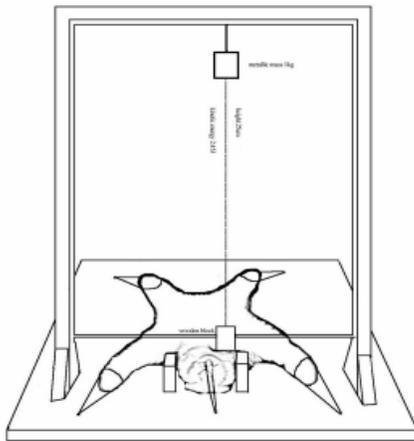


Fig. 1 the striking instrument was constructed by a scaffold and a metallic and two cuboid wooden blocks

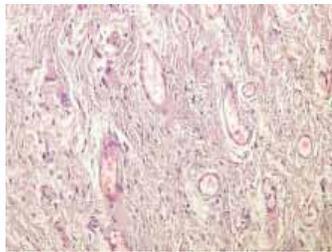


Fig. 2 the adhesion tissues was loose connective tissue with abundant blood supply in early stage

The joint adhesive tissue of the patients with long- term opening limitations after condyle fractures in the early stage was a fibrosis strips composed of loose connective tissue with an abundant supply of blood (Figure 2) supply and dense connective tissue and cartilage in the late stage.

Animal experiment and histological data

The experimental animals awoke gradually, about half an hour 30 min post-trauma. In the first day after trauma, the diet of all animals decreased in comparison with that before trauma. Thereafter, normal diet was resumed. Opening and chewing were

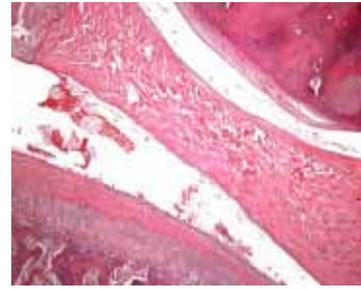


Fig.3. 24h post-trauma, the struck side showed detachment and fissures of condyle and glenoid fossa cartilage and joint hemorrhage

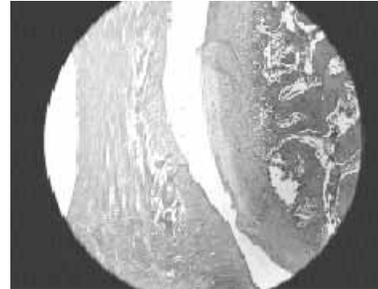


Fig.4. one week post –trauma, the struck side showed denaturalization, degeneration and fissures on the condyle surface and chondrification and degeneration of the disc

not affected and the animal’s weight increased consistently.

Macroscopic examination showed that none of the animals suffered a condyle and/or glenoid fossa fractures. No evidence of distinct joint capsule and joint ligament trauma was found in any case. The histological findings were as follows:

24 h post-trauma: the struck side showed detachment and fissures of condylar and glenoid fossa cartilage and joint hemorrhage (Figure 3). The control side showed uneven of the condyle surface.

1 week post-trauma: The struck side showed denaturalization, degeneration and fissures on the condyle surface and chondrification and degeneration of the disk (Figure 4). The control side showed fissures of the condyle surface and concave disk

Table 2 Clinical diagnoses of the 41cases

Diagnoses Cases	
disk disorders	3
disk disorders and synovitis	6
disk disorders, synovitis and masticatory muscle myositis	6
disk disorders and osteoarthritis	5
disk disorders, osteoarthritis and synovitis	6
disk disorders, osteoarthritis, synovitis and masticatory muscle myositis	5
osteoarthritis and synovitis	1
osteoarthritis, synovitis and masticatory muscle myositis	1
synovitis	5
masticatory muscle myositis	1
adhesion in joint cavity	2
total	41

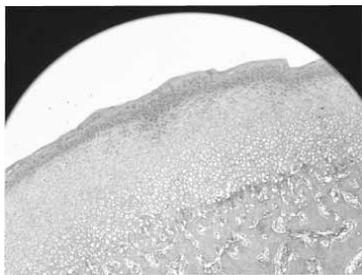


Fig.5. two weeks post-trauma, the whole condyle surface was uneven with the fibrous layer becoming thinner or disappearing. The hypertrophy and proliferation layers became thick.

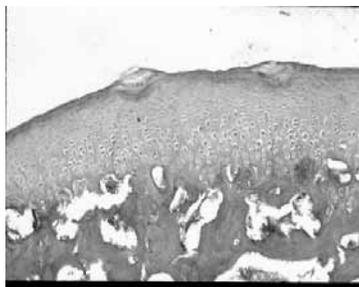


Fig. 6. one month post-trauma, the struck side showed thinning and fibrillation of fibrosis layer and obvious thickening of the hypertrophy and proliferation layers of condyle cartilage

defects of the disk.

2 weeks post-trauma: The whole condyle surface was uneven with the fibrous layer becoming thinner or disappearing all together. The hypertrophy layer and proliferation layers became thick (Figure 5). The control side showed fissures or disappearance of part of the condyle fibrosis layer and thickening of the proliferation layer.

1 month and 2 months post-trauma: The struck side showed thinning and fibrillation of fibrosis layer and obvious thickening of the hypertrophy and proliferation layers of condyle cartilage (Figure 6). More obvious repairing changes could be seen in the specimens two months after trauma than the specimens one month after trauma (Figure 7). The control side also showed hypertrophy of condyle cartilage.

Discussion

The concept and classification of TMJTA.

Little attention has been paid to TMJ traumatic arthritis (TMJTA) in the literature and the affliction lacks a clear definition was seldom mentioned and its definition was not clear in the literature. Some authors have argued that TMJ traumatic arthritis may be classified divided into as acute and chronic two forms; the acute one was form being caused by acute trauma and the chronic one form being was lingering the result of lingering effects of a acute trauma⁶⁾. Others did not definitely illuminate the have treated TMJTA as a unitary form of arthritis concept in their studies⁷⁾. Here, we proposed that TMJTA could mainly be divided into two types: one was caused by TMJ blunt trauma, and the other was caused by condyle and/or glenoid fossa fracture. Acute TMJTA was caused by acute TMJ trauma and effects could linger and became chronic one. Degenerative changes or osteoarthritis could happen as the result of clinical progression in these two types.

Acute TMJTA may linger persist into and become a chronic one condition. The exact precise time boundary of at which acute TMJTA becomes chronic TMJTA, however, was difficult to ascertain. There is still few relative report in human traumatic arthritis till now. Tulamo, Thea Finnishland veterinarian Tulamo,

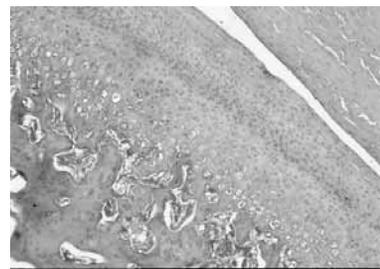


Fig. 7. two months post-trauma, more obvious repairing changes could be seen in the condyle cartilage

in his two papers of 1994 and 1996, has suggested that the horse's traumatic arthritis in horse could be classified as acute traumatic arthritis, if initial lameness had persisted less than 2 weeks; or chronic, if the duration of lameness had existed remained for more than 4 weeks^{8,9)}. However, the evidence for this classification sheme was not provided. In the diagnostic standard for juvenile chronic arthritis, the disease's duration was defined as over 6 weeks¹⁰⁾. According to our knowledge, the symptoms and signs of traumatic arthritis induced by blunt trauma and persisted over one month generally could not heal in a short duration and might progress into chronic symptoms ones. In addition, Walker proposed that the aim of treatment of condyle fracture was to acquire normal movement without pain of mandible and TMJ soon after trauma¹¹⁾. But he did not suggest the exact recuperation time from trauma. In most investigations related to condyle fracture, follow-up time was usually more than half a year 6 months. The lingering symptoms and signs were regarded as complications^{12,13)}. Our clinical experience also suggests that if the symptoms and signs of condyle fractures persist over for more than half a year, they could generally do not subside in a short time. Therefore, the time boundary of acute and chronic TMJTA caused by blunt trauma and TMJTA caused by condyle fractures was suggested as one month and six months, half a year respectively.

Clinical features of TMJTA

In the patients studied here, the most common TMJTA symptoms of TMJTA was a limited ability to opening limitation the mouth. Joint pain was also a frequent familiar accompanying symptom. There were some other patients who presented simply reported only joint clicking or joint pain. A few patients suffered from accompanied with some symptoms such as chronic masticatory muscle pain, chewing disability and jugular shoulder muscle pain etc.

The All cases of the TMJTA-BT examined here could be clinically classified into as: disk disorders, synovitis, masticatory muscle myositis, joint adhesion, and mixed pathological changes. Besides, if pathological examination could be performed, it was probable that the cases showing only one clinical or imaging manifestation could also had various other kinds of pathological changes. Therefore, precise classification of symptoms and pathology of TMJTA induced by blunt trauma are often simultaneously mixed up by several kinds of pathological events clinically may be complicated by the variety of consequences. Most patients with TMJTA-CF had condylar displacement or absorption deformity which implied the pathological basis of joint morbidity.

Goss and Bosanquet used arthroscopic examination of the upper joint cavity and found bilateral joint trauma-related changes in unilateral mandible striking cases through arthroscopic examination of upper joint cavity¹⁴⁾. There are still more other studies reportings have indicated that joint symptoms could also happen in the non-condyle-fracture side^{15,16)}. In the current study, there were 5 unilateral condylar fracture cases with contra-lateral

joint morbidity. Furthermore besides, control-lateral joint traumatic changes could also be found in the animal experiment, which implied suggesting that striking of unilateral striking of the mandible could impact both sides of the joint on both sides of the jaw TMJs.

Pathological Basis of TMJTA

The results of the present animal experiment study showed that TMJTA induced by acute blunt trauma could cause joint damage such as cartilage detachment, joint hemorrhage, and exudation immediately after trauma. And then, joint self-repairing mechanisms of tissue started and maintained were in effect for a longer period. Opening limitation was the most common symptom of condylar fracture. These clinical and histological observations of this study suggest that joint adhesion may underlie the opening limitation after condyle fractures, and could ultimately develop into fibrosis or bony ankylosis.

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