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ORIGINAL ARTICLE

Early diagnostics of temporomandibular joint structural elements injures caused by traumatic mandibular bone fractures

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Article history: Received: 03.12.2016 Accepted: 03.03.2017 Published: 30.06.2017

SUMMARY: A rapidly increasing number of mandibular condylar fractures and some complications related to injuries of temporomandibular elements make this study important. Intra-articular disorders lead to secondary pathological findings such as osteoarthritis, deforming osteoarthrosis, and temporomandibular joint ankylosis that limits mouth opening, mastication, swallowing, breathing, and decreased/lost working capacity or disability. Early diagnosis of intra-articular disorders can prevent from long-lasting functional complications caused by temporomandibular joint injuries.

This study was performed for the purpose of early detection and investigation of organic pathological changes in the cartilaginous and osseous tissues of the temporomandibular joint caused by traumatic fractures of the mandibular condyle. Twenty patients underwent a general clinical examination, magnetic resonance imaging (MRI), and immune-enzyme testing for biochemical markers of connective tissue injury (pyridinoline and deoxypyridinoline) in urine. Disk dislocation, deformation, adhesion, perforation or squeeze, tension or disruption of ligaments, and injury of articular surfaces are among complications of mandibular fractures that can be revealed on MRI. As regards biochemical findings, we revealed a sharp rise in the levels of pyridinoline and deoxypyridinoline before treatment and a lack of stabilization within 21 days of treatment.

KEYWORDS: mandibular articular process fractures, temporomandibular joint

INTRODUCTION

Mandibular fractures predominate among the traumatic pathologies of the maxillary-facial area, comprising 74-90% of all cases, while the frequency of mandibular condylar fractures ranges from 26% to 40% [1,2].

An anatomically and physiologically tight connection between the mandibular bone and the temporomandibular joint as well as multifunctioning of the maxillofacial system are the reasons why it shall be considered as an integrated mechanism. That is the why traumatic mandibular fractures directly affect structural elements and might cause long-lasting functional disorders [3].

Intra-articular disorders inevitably lead to secondary pathologies such as deforming osteoarthritis or epiphysiolysis of cartilaginous tissue. As a consequence, undiagnosed mechanical trauma of the condylar process, which can be observed in teenagers, results in osteoarthritis and ankylosis of the temporomandibular joints [4,5].

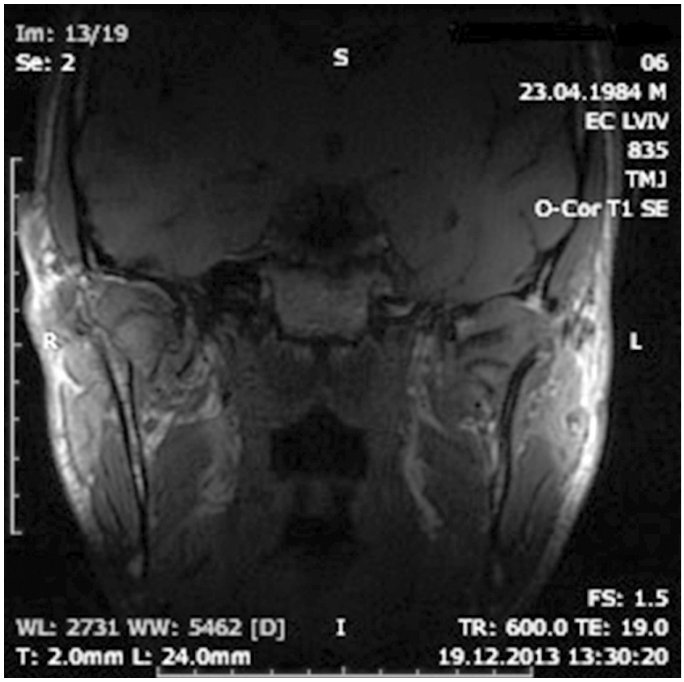
Based on our previous research, the frequency and kind of temporomandibular joint injuries significantly depend on fracture localization, blow power, and extrusion rate. Blast injury, tension or disruption of ligaments, articular disk extrusion, squeeze and deformation, and violation of joint capsule integrity are observed in the temporomandibular joint [6].

Two collagen types (I and II) that are found in the temporomandibular joint make this structure unique. Some cross-connections among certain stabilizing collagen molecules such as pyridinoline and deoxypyridinoline are evident in the ossein (the former is typical for the osseous tissue and the latter is mostly observed in type I collagen). Pyridinoline is predominantly observed in cartilages and ligaments (type II collagen) [7,8]. Pyridinoline and deoxypyridinoline are not metabolized in the process of collagen resorption but are excreted in urine. According to numerous studies, the complex formed by pyridinoline and deoxypyridinoline is a reliable indicator of osseous and cartilaginous tissue destruction due to traumatic temporomandibular injury, which allows for an early differential diagnosis and evaluation of the structural elements of the temporomandibular joint and an adequate planning of treatment and rehabilitation in patients suffering from traumatic mandibular condylar fractures [9].

The aim of the study is to focus on an early diagnosis of injuries observed in cartilaginous and osseous tissues of the temporomandibular joint due to traumatic fractures of mandibular articular processes. Moreover, the role of MRI and biochemical screening is investigated.

METHODS

Twenty-two male inpatients, aged 18-25 years, with traumatic fractures of the temporomandibular joint who underwent treatment in the maxillo-facial surgery departments of Lviv Regional Clinical Hospital and Lviv City Clinical Emergency Care Hospital



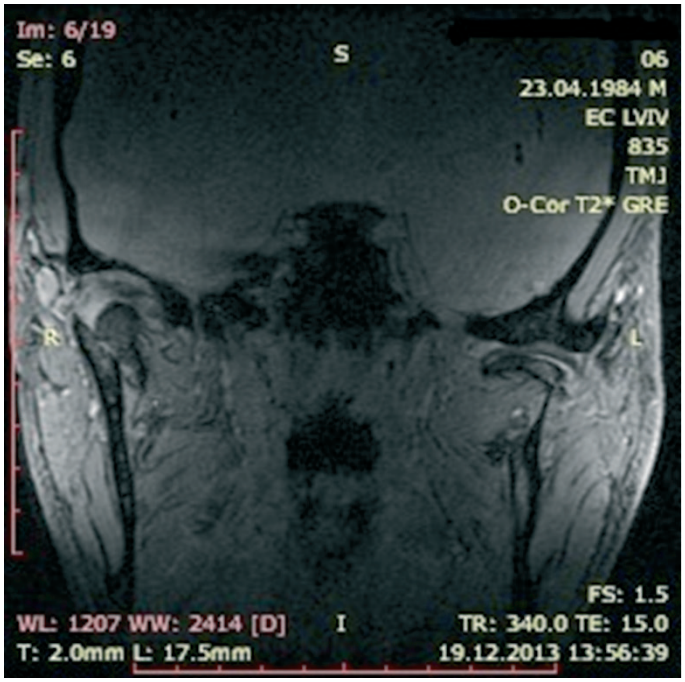


Fig. 1.1, 1, 2. Fractures of the right articular process head and left articular process cervix with distal fragment rotation are depicted in Figures 1.1 and 1.2 and on E2*GRE-weighted images.

were examined in 2014-2016. Clinical symptoms of acute posttraumatic temporomandibular joint arthritis (pain, swelling, limited mouth opening etc.) were observed in all patients. The patients underwent osteosynthesis of the mandibular condylar process by applying titanic mini plates.

A special coil designed for imaging of the temporomandibular joint was used. Standard scanning was performed bilaterally, and the following sequences were used: PD FSE, T1, T2, STIR, and T2*GRE. The revealed pathological findings were studied in the axial, coronary, oblique coronary, and sagittal planes. An optimal section thickness is 1.5 – 2.5 mm, with spaces between them of 0.5 mm. The area of examination included the ascending ramus of the mandible, temporal fossa floor, and the external auditory passage.

The levels of pyridinoline and deoxypyridinoline in urine were defined by an enzyme-immunoassay and a set of reactive chemicals produced by "Metra DPD" (France) in order to evaluate the injury of temporomandibular osseous and cartilaginous tissues. The measurement wave was 405 nm long, the measuring range was 1.1-300 nM, and analytical sensitivity was 1.1 nmol/l [10, 11]. Laboratory studies were conducted before treatment and on day 21, 30, and 180 after immobilization.

Mathematical and statistical processing of all numerical variables was accomplished by means of a personal computer with "StatSoft Statistica 8" software. Means, relative rates, and errors were calculated. The Wilcoxon criterion was applied for comparing values.

RESULTS

While examining the type of mandibular condylar process fractures, injuries of temporomandibular elements of different rates and natures were revealed in 22 patients on MRI. The following injuries of joint structures were the most frequent: hemarthrosis was revealed in 20 patients (90.91± 6.27%), disk dislocation was observed in 15 patients 68.18 ±10.16), disk deformation was detected in 12 patients (54.55 ±10.87%), disk adhesion was diagnosed in 8 patients (36.36 ± 10.50%), disk perforation was evident in 3 cases (13.64 ±7.49%), tension of ligaments was found in 15 patients (68.18 ± 10.16%), breaking of ligaments was detected in 6 cases (27.27 ±9.72%), and damage of joint surfaces was observed in 5 patients (22.73 ±9.14%).

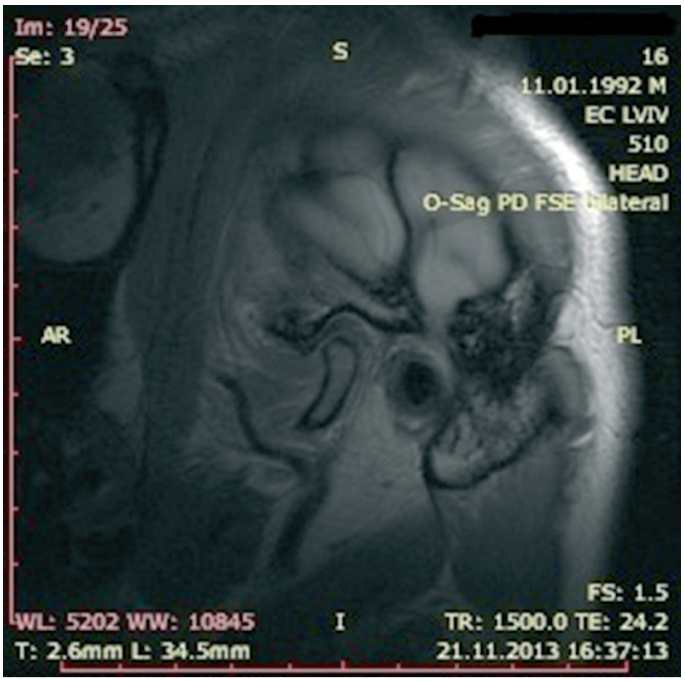


Fig. 2. A ruffled contour of the lower fibrous band is visualized on PD FSE, indicating a slight tear.

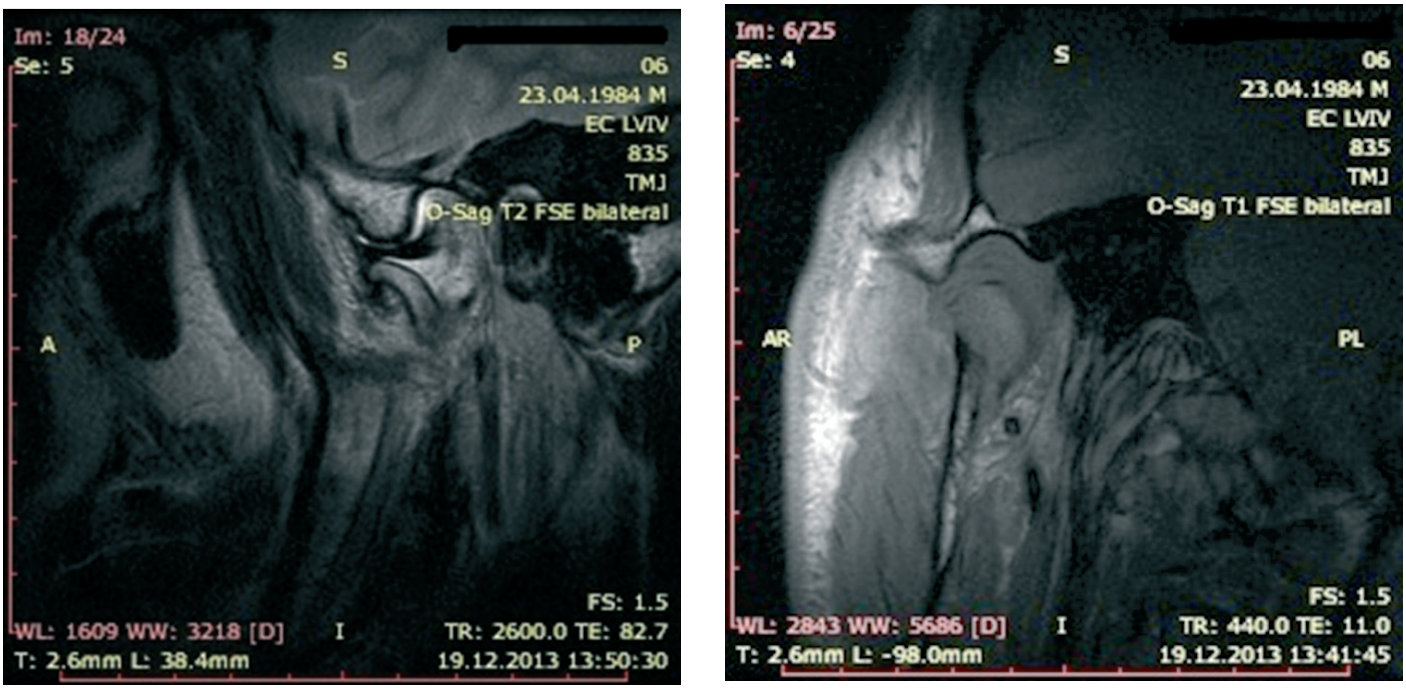


Fig. 3.1., 3.2. Isointense and hyperintense signals on T1- and T-weighted images are visualized in the joint gap, indicating that hemorrhagic components are due to hemarthrosis.

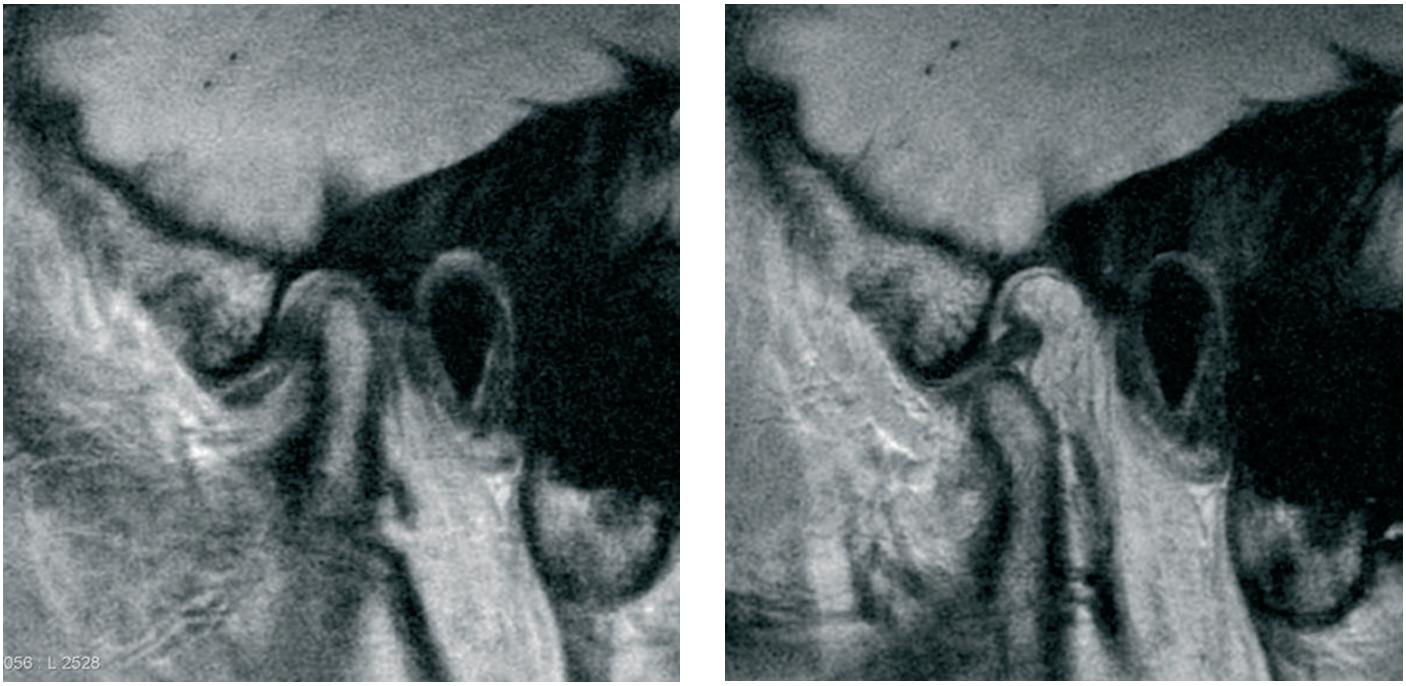


Fig. 4.1, 4.2. Disk dislocation with restoration of the typical meniscus location: ventral meniscus dislocation is observed when the mouth is closed, while the typical meniscus allocation is evident with the mouth open.

Condylar process fractures in the form of a high-signal oblique line passing through the right articular process head and left articular process cervix are depicted in Figures 1.1 and 1.2.

A ruffled contour of the lower fibrous band is visualized on PD FSE, indicating a slight tear (Figure 2).

Hemarthrosis is depicted in Figures 3.1 and 3.2 as a hyperintense signal on T1- and T2-weighted images. Meniscal tear is accompanied by two hypointense fragments located around the articular process head with preserved location in relation to the latter on mouth opening.

Isointense and hyperintense signals on T1- and T2-weighted images are visualized in the joint gap, indicating hemorrhagic components as the symptoms of hemarthrosis (Figures 3.1 and 3.2).

Dynamic joint scanning allows for an evaluation of the mechanics of this anatomical structure and detection of meniscus dislocation (Figure 4.1 and 4.2).

Articular disk perforation caused by a rigid dislocation of joint surfaces is depicted in Figure 5.

Eighteen patients (90.00 ± 6.88%) suffered from hemarthrosis in combination with disk damage. In 19 cases (95.00 ±5.00%), hemarthrosis was accompanied by ligament tension or disruption. In only 3 cases (15.00±8.19%), hemarthrosis was accompanied by trauma of articular surfaces.

Biochemical screening revealed a sharp increase in the levels of pyridinoline and deoxypyridinoline before treatment, with the mean value of 150.82±10.73 and 37.00 ±2.22 nmol/mmol of creatinine, respectively (Table 1).

A decrease in the levels of pyridinoline and deoxypyridinoline was not significant 21 days after treatment, being equal to 136.36 ± 10.50 and 33.64±2.36 nmol/mmol of creatinine, respectively. The examined indicators dropped to the minimum level of 121.27±9.40 and 31.05±2.12 nmol/mmol of creatinine, respectively. After 6 months, tt reached the normal rates of 66.45±3.82 and 19.09±1.15 nmol/mmol of creatinine, respectively .

A comparison of the mean values of pyridinoline and deoxypyridinoline before treatment, on days 21, 30, and 180 after treatment revealed a statistically significant difference. A comparison of the mean values of pyridinoline and deoxypyridinoline measured on day 21, day 30, and 6 months after treatment revealed a significant difference ($P<0.001$). A comparison of the mean values of pyridinoline and deoxypyridinoline measured 30 days and 6 months after treatment revealed a statistically significant difference. Consequently, a substantial decrease in the mean values of pyridinoline and deoxypyridinoline ($P<0.001$) was revealed in patients under examination.

On discharge (21 days after treatment), pyridinoline and deoxypyridinoline normalization was observed only in two patients (9.09±6.27). Normal rates were revealed only in four patients at follow-up conducted 30 days after treatment (18.18%±8.42). Pyridinoline and deoxypyridinoline normalization 6 months following the trauma occurred in only 10 patients (45.45%±10.87).

Fig. 5. Articular disk perforation

CONCLUSIONS.

Currently, magnetic resonance imaging is the only comprehensive diagnostic technique applied for detecting temporomandibular joint injuries, as it can only reveal structural pathologies of soft tissue and fibrous structures but also serves as the basis for choosing an appropriate treatment. Biochemical findings indicate the beginning of organic pathological changes in temporomandibular structural elements, both osseous and fibrous. A sharp and long-lasting increase in pyridinoline and deoxypyridinoline indicates osseous tissue damage and articular cartilage destruction.

In all cases, a close correlation between biochemical findings and magnetic resonance imaging was revealed, which is in line with the clinical presentation of posttraumatic temporomandibular arthritis. The lack of full and timely normalization of pyridinoline and deoxypyridinoline indicates the need to develop new approaches for treating patients with temporomandibular trauma in order to prevent posttraumatic temporomandibular arthrosis and ankylosis.

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Word count: 1450 Page count: 5 Tables: 1 Figures: 5 References: 11

DOI: 110.5604/01.3001.0010.1022

Table of content: http://ppch.pl/resources/html/articlesList?issueId=9993

Competing interests: The authors declare that they have no competing interests.

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Cite this article as:

Pohranychna Kh R., Stasyshyn A.R. , Matolych U.D.; Early diagnostics of temporomandibular joint structural elements injures caused by traumatic mandibular bone fractures; Pol Przegl Chir 2017: 89 (3): 31-35