

# The application of computed tomography and magnetic resonance imaging at diagnostics of the human maxillofacial system

V Nikitin<sup>1</sup>, E Karavaeva<sup>2</sup>, Yu Cherepennikov<sup>3</sup> and I Miloichikova<sup>3</sup>

<sup>1</sup> Perm National Research Polytechnic University, 29 Komsomolskiy prospect, Perm, 614990, Russia

<sup>2</sup> Perm State Medical University named after Academician E.A. Wagner, 26 Peter and Paul Street, Perm, 614990, Russia

<sup>3</sup> National Research Tomsk Polytechnic University, 30 Lenin Avenue, Tomsk, 634050, Russia

E-mail: sortior@mail.ru

**Abstract.** The application of computed tomography and magnetic resonance imaging has entered into wide practice at diagnosis of the maxillofacial system. Computed tomography allows us to obtain information about only bone structures. Magnetic resonance imaging gives information about bone and soft tissue structures of the maxillofacial system. The sagittal and coronal projections should make for complete diagnosis of the temporomandibular joint, because the articular disc is very mobile structure. We suggest that the temporomandibular joint can influence the internal carotid artery at medial displacement of the articular disc. As a result of analysis of the literature and our own studies concluded that changes TMJ affect the internal carotid artery.

## 1. Introduction

The application of computed tomography and magnetic resonance imaging has entered into wide practice now at diagnosis of the human maxillofacial system. Computed tomography allows us to give information about bone structures: the mandible and the skull. Significant disadvantage of computed tomography is impossibility of evaluation of the condition of soft tissue structures of the maxillofacial system (muscles, ligaments, articular disc) [1, 2, 4].

One of basic elements of the maxillofacial system is the temporomandibular joint disc. It consists of the condyle of the mandible, glenoid fossa and tubercle of the temporal bone and articular disc between the mandible and the temporal bone [1]. The temporomandibular joint disc is are incongruent, i.e. these articular surfaces do not coincide in shape. The disc takes particular importance in incongruent joints because it smooths out geometric differences of the articular surfaces for realizations of various movements [2, 3, 4].

Many diseases of the maxillofacial system are associated with soft tissues. For example, of the temporomandibular joint dysfunction, when the temporomandibular joint disc does not take normal place [1]. At the same time, computed tomography can not visualize of the disc and its position relatively articular surfaces. This dysfunction can be caused by incorrect functioning of muscles. In this case, the muscles can have values of efforts close to limit values (maximal values, which can be created). Also in this case, computed tomography can not visualize of the muscles. Also in this case,



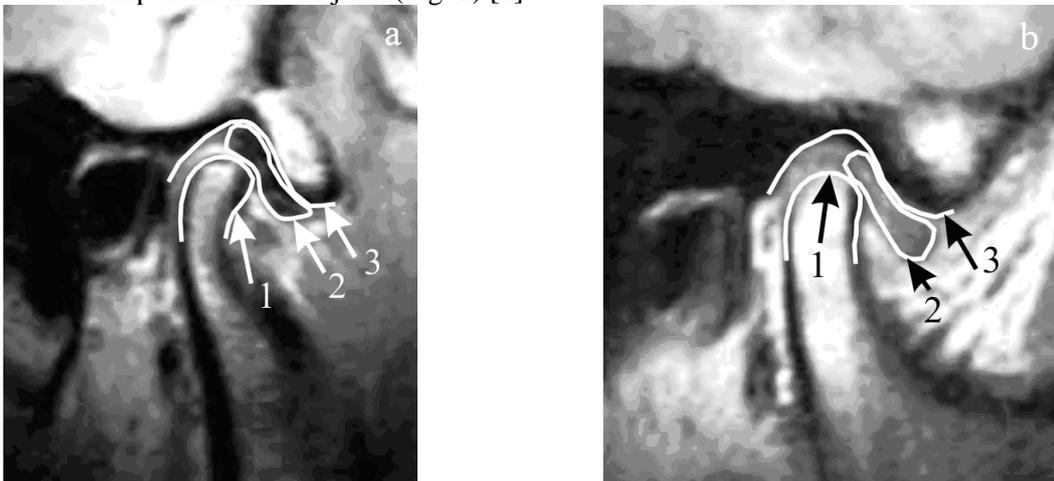
computed tomography can not visualize of the muscles. Besides, computed tomography causes additional radiation exposure on the human, reduction of which is highly relevant issue [5, 6].

In this paper, authors present necessity of application of magnetic resonance imaging at diagnostics of the human maxillofacial system for development of method of individual treatment of diseases of the maxillofacial system. This method allows us to include position of the temporomandibular joint disc and directions of muscles.

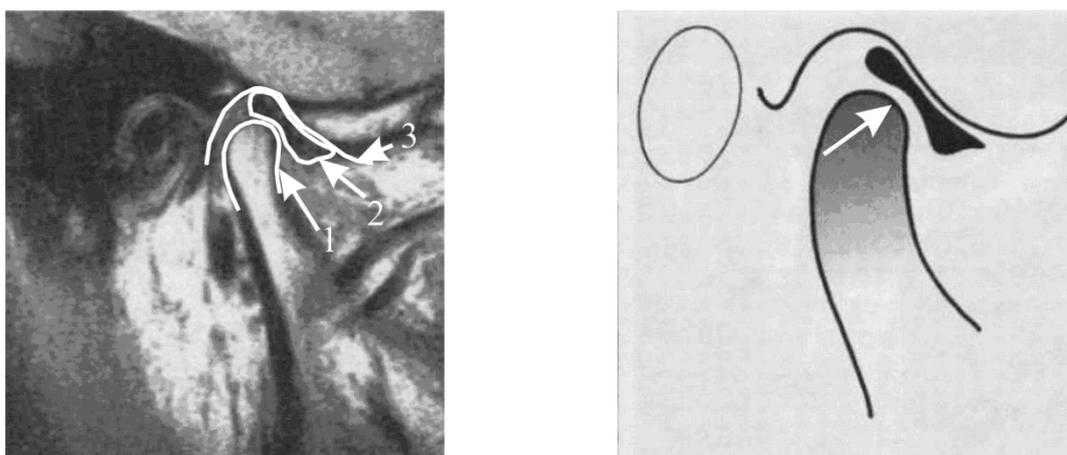
## 2. Materials and methods

The temporomandibular joint is one of the most interesting joints, because the disc makes significant displacements allowing perform different movements [2, 3, 4].

One of important characteristics defining condition of the temporomandibular joint is the articular disc (Fig. 1). The position of the disc in norm and pathology is shown in Fig. 1, when the jaws are closed [1]. The position of the temporomandibular joint disc is very important parameter, because it determined the point of application of the temporomandibular joint reaction. This point belongs both surfaces of the disc and the mandible. It is determined as the shortest distance between the articular surfaces of the temporomandibular joint (Fig. 2) [2].



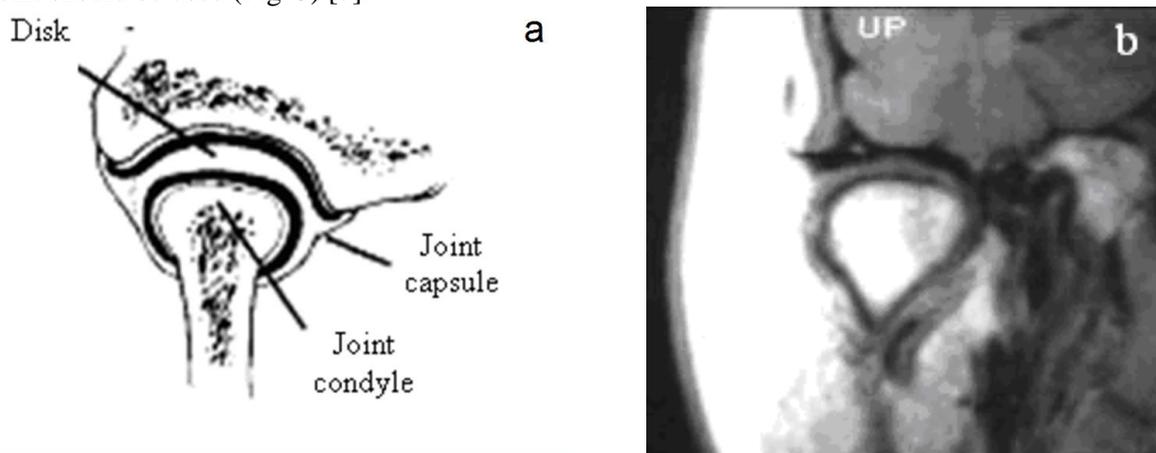
**Figure 1.** Position of the temporomandibular joint disc: a - is norm; b - is anterior displacement (pathology) [1] (1 is condyle; 2 is disk; 3 are glenoid fossa and tubercle of the temporal bone)



**Figure 2.** Magnetic resonance imaging of the temporomandibular joint in oblique sagittal projection (projection performed under angle to the sagittal projection): 1 is condyle; 2 is disk; 3 are glenoid fossa and tubercle. Interposition of articular structures in central occlusion is normal. Arrow shows the central zone of the disk and vector of chewing load in the diagram [2]

The direction of chewing load in norm is shown at the normal position of the disc in Fig. 2. It can be seen that the load is applied in the central zone of the disc and action line of chewing load passes through shortest distance between the articular surfaces [2]. Accordingly, the direction of the temporomandibular joint reaction is directed to the opposite side.

But, only sagittal projection of the temporomandibular joint is not allows us to characterize of position of the disc relatively the articular surfaces. The coronal projection of the temporomandibular joint should be used (Fig. 3) [7].



**Figure 3.** Articular disk in norm as the first target of the damage at redistribution of biomechanical masticatory pressure: a - is schematic figure; b - is magnetic resonance imaging (MRI) [7]



**Figure 4.** Magnetic resonance imaging of dislocation of the disk on medial surface of the temporomandibular joint condyle (black arrows show represent border of the disk shifted medially) [8]

The sagittal and coronal projections of the temporomandibular joint allow us to estimation of possibility of development of pathological processes into the disc [9]. Its position influences position of determine the point of application of the temporomandibular joint reaction (see Fig. 2).

The information about coordinates of the point of application of the temporomandibular joint reaction allows us to determine values of efforts of muscles and value and direction of the reaction [10].

### 3. Results and discussion

Magnetic resonance imaging allows us to obtain the attachment points and sizes of muscles and ligaments of the human maxillofacial system. These parameters characterize individual features of the maxillofacial system. Thus, they influence efforts of the human maxillofacial system.

But, magnetic resonance imaging is used less frequently than computed tomography in the practice of dentists. Thus, computed tomography is not includes diagnosis of major structures of the maxillofacial system. According to the authors, magnetic resonance imaging should be used together this computed tomography for individual estimation of condition of the maxillofacial system and development of method of individual treatment of diseases of the maxillofacial system.

Changes of the maxillofacial system influence different processes and systems of the human organism [11-19]. For example, cardiovascular system includes in these system. The internal carotid artery is one of arteries involved in blood supply to the brain. Internal carotid artery is located close to the temporomandibular joint.

Coronal projections of temporomandibular joints and internal carotid arteries are shown in Fig. 5. This case illustrates possible influence of condition of the temporomandibular joint on the internal carotid artery.



**Figure 5.** Magnetic resonance imaging of the patient A 68 years with infringement of the support zone (absence of right molars) of the right temporomandibular joint in general mode (upper part) (1 is asymmetric enlargement of the right temporomandibular joint due to structures of the medial pole; 2 are fragments of the right internal carotid artery); in the vascular mode (lower part) (tandem stenosis of the right internal carotid artery at the level of the right temporomandibular joint (2) and in the area of the bifurcation of the vessel on the brain artery (3). Pathology of the left internal carotid artery have been identified [8]

#### 4. Conclusion

In this paper, authors present sagittal and coronal projects of magnetic resonance imaging, which show condition of the temporomandibular joint. Magnetic resonance imaging allows us to estimation of position of the temporomandibular joint disc, development of pathological processes, which is not indicated at using of computed tomography.

Abnormal position of the disc entails to changing of the efforts of the maxillofacial system and stresses into the disc. Large values of stresses compared to limit stresses entail to development of processes into the disc and also the bone tissue of the condyle [2, 4].

## Acknowledgments

This work was partly supported by the Competitiveness Enhancement Program of Tomsk Polytechnic University.

## References

- [1] Mello C F Jr, Saito O C and Guimarães Filho H A 2011 Sonographic evaluation of temporomandibular joint internal disorders *Radiol. Bras.* **44** **6** 355-359.
- [2] Khvatova V A 2005 *Clinical gnatology* (Moscow: Meditsina) (in Russian).
- [3] Ingawalé S M, Goswami T 2012 *Biomechanics of the temporomandibular joint. Human Musculoskeletal Biomechanics* ed. T Goswami (Croatia)
- [4] Nordin M, Franke V H 2001 *Basic biomechanics of the musculoskeletal system* (Philadelphia: Lippincott Williams & Wilkins)
- [5] Stuchebrov S, Batranin A, Verigin D and Wagner A 2014 Setups for Tomographic Imaging with Submillimeter Spatial Resolution *J. of Phys.: Conf. Ser.* **517** Article number 012046
- [6] Stuchebrov S, Batranin A, Verigin D, Lukyanenko Y, Siniagina M and Wagner A 2014 Estimation of radiation doses in X-ray visualization of biological objects *Adv. Mat. Res.* **880** 53-56
- [7] Information on [http:// www.tmjsurgeon.com/tag/tmj-surgery](http://www.tmjsurgeon.com/tag/tmj-surgery)
- [8] Information on [http:// www.imaging.consult.com](http://www.imaging.consult.com)
- [9] Nikitin V N, Tverier V M, Nyashin Y I and Oborin L.Ph. 2014 The temporomandibular joint reaction and masticatory muscle tensions *Russian Journal of Biomechanics* **18** **2** 167-179
- [10] Norer V, Pomaroli A and Dize O 1989 Evaluation of degerativnye process in the articular disc of the temporomandibular joint *Diseases of the temporomandibular joint* (Moscow) pp 105-112 (in Russian)
- [11] Desvarieux M, Demmer R T, Rundek T, Boden-Albala B, Jacobs D R J, Papapanou P N and Sacco R L 2003 Relationship between periodontal disease, tooth loss, and carotid artery plaque: the oral infections and vascular disease epidemiology study (INVEST) *Stroke* **34** 2120-2125
- [12] Joshipura K J, Douglass C W and Willett W C 1998 Possible explanations for the tooth loss and cardiovascular disease relationship *Ann. Periodontol* **3** 175-183
- [13] Joshipura K J, Hung H-C, Rimm E B, Willett W C and Ascherio A 2003 Periodontal disease, tooth loss, and incidence of ischemic stroke *Stroke* **34** 47-52
- [14] Joshipura K J, Rimm E B, Douglass C W, Trihopoulos D, Ascherio A and Willett W C 1996 Poor oral hearth and coronary hearth disease *J. Dent. Res.* **75** **9** 1631-1636
- [15] Oborin L F, Patlusova E S 2009 Interaction of biomechanical and hemodynamic factors under congenital and acquired injuries of the temporomandibular joint *Russian Journal of Biomechanics* **13** **4** 88-99
- [16] Oborin L F, Shmurak M I 2010 About mechanism of influence of the collateral circulation of the brain on development of the atrophic, pain, and others syndromes of the dentofacial system *Russian Journal of Biomechanics* **14** **1** 64-71
- [17] Paunio K, Impivaara O, Tiekso J and Maki J 1993 Missing teeth and ischaemic heart disease in men aged 45-64 years *Eur. Heart J.* **14** 54-56
- [18] Schillinger Th, Kluger W, Exner M, Mlekusch W, Sabeti S, Amighi J, Wagner O, Minar E and Schillinger M 2006 Dental and periodontal status and risk of progression of carotid atherosclerosis: the inflammation and carotid artery risk for atherosclerosis study dental substudy *Stroke* **37** 2271-2276
- [19] Simanovskaya E Y, Elovikova A N, Tverier V M and Nyashin Y I 2004 Biomechanical description of the functional features of human masticatory apparatus in norm and in various pathological processes *Russian Journal of Biomechanics* **8** **4** 15-26