DEPENDENCE OF STRESS STRAIN OF DENTAL HARD TISSUES AND PERIODONT ON HORIZONTAL DEFORMATION DEGREE

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The cause-and-effect connection for dental arches deformations is high prevalence of hard dental tissues pathology and associated anomalies of occlusal relations [1,2,3]. Besides, the morphological features of the dentofacial segments, dental arches and the dentofacial area have a significant impact on pathology development [4,5,6]. Clinical dentistry attaches particular importance to dental arches deformation in the horizontal direction. Totally opposite treatments have been proposed: in some cases, the orthodontic treatment is recommended prior to prosthetics, while in others the treatment policy implies odontopreparation of the proximal surfaces of the teeth, which limit the defect, before creating parallel walls [7,8,9]. Teeth and morphological structures of the dentofacial area get stress-strained under various effects, both physiological and pathological [10,11,12]. However, issues related to selecting the optimal location for the teeth roots when performing dental arch defect prosthetic treatment, still remain relevant. The points that cause issues include questions regarding stress-strain status of abutment teeth located at a certain angle towards each other, which stands behind the aim of the present study.

Aim of study

To identify the dependence of the stress-strain status of dental hard tissues and periodont on the horizontal deformation.

MATERIAL AND METHODS

To conduct this study, a mathematical model was developed, which allowed assessing the stress-strain status occurring in the dental hard tissues and in the periodont against the chewing load. The stress status was measured in megapascals (MPa). At the same time, the elastic properties of model materials (Young's modulus, Poisson's ratio) for dentin tissue were 1,560 MPa, $\upsilon = 0.32$; for periodontal tissues they were significantly less ($E = 15$ MPa, $\upsilon = 0.45$), whereas for the bone tissue they reached the maximum values of 20,000 MPa ($\upsilon = 0.3$). The models were distributed into 4 groups. Group 1 included the deformation simulation of 10° to 15°. Group 2 consisted of models where the medial inclination of the first mandibular molar varied from 16° to 25°. In the third group, the horizontal deformation was 26–35°. The fourth group had a teeth inclination varying from 36° to 50°. When estimating the deformation status, displacement scales (mm) and von Mises equivalent stress patterns (SEQV) were used.

RESULTS AND DISCUSSION

In case of a mesial inclination of the mandibular molar towards the defect, the observed models of the dentofacial segments featured redistribution of the loads, the dependence of which was determined by the respective tooth inclination. Where the inclination was 10–15° at the mesial occlusal surface of the crown near the first order central groove, the stress status was 5.0±0.13 MPa. With an increase in the tooth inclination from 16° to 25°, the value increased up to 7.0±0.13 MPa. As for Groups 3 and 4 models, the indicators were 9.5±0.11 MPa and 14.5±0.11 MPa, respectively. At the mesial root, in its cervical third, the stress status was 1.28±0.46 MPa. In Groups 2, 3 and 4, the parameter in question was 1.88±0.22 MPa, 2.7±0.21 MPa and 2.87,8±0.18 MPa. The stress status at the septum interradiculare in Group 1 was an average of 0.98±0.26 MPa, and slightly decreased beyond the tops of the teeth roots going down to 0.64±0.12 MPa. In Group 2, the stress status at the area of the septum interradiculare, was 1.12±0.22 MPa; in Group 3, the indicators increased up to 1.5 MPa, while in case of the tooth inclination of 36° to 50°, the parameter was 1.82±0.16 MPa. The deformed status value also varied in view of the tooth inclination. In the model plane image of the total displacements, the deformed status value at the central fissure (with the tooth inclination of 10° to 15°) was 0.045±0.004 mm. In the bone tissue, deformation was observed at the tooth neck and the cervical third of the root, while the deformation status value, based on vectors, was 0.033±0.002 mm. An inclination increase up to 16–25° resulted in bringing the studied parameters at the tooth crown to 0.06±0.005 mm, which exceeded significantly similar values for deformation of up to 15°. From the distal molar neck surface to the cervical third of the root, the deformed status value was 0.045±0.003 mm. In Group 3, the deformed status indicators at the tooth crown were 0.065±0.004 mm, and in the bone tissue — 0.047±0.003 mm. In Group 4, the indicators were 0.10±0.005 mm and 0.088±0.003 mm, respectively.

CONCLUSION

Horizontal deformation of the dental arches, accompanied with a distal tooth mesial inclination, comes along with changes in the stress-strain status in the teeth hard tissues as well as in the periodontal complex tissues, whose severity is determined by the inclination degree and the type of deformation. The data obtained can be used in clinical practice of orthopedic dentistry for diagnostic purposes and to select methods for preprosthetic orthodontic treatment.

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