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ASSESSMENT OF IMPACT WAVE MOVEMENT THROUGH NON-STANDARD CONTRA-FORCES IN THE MAXILLOFACIAL REGION POST ELECTRIC SCOOTER ACCIDENTS

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Abstract:
The use of personal mobility devices, particularly electric scooters, is rapidly increasing, which is accompanied by a rise in injuries, including those in the maxillofacial region. Studying the propagation of shock waves through unusual contra-forces in this area following electric scooter accidents can provide a deeper understanding of injury mechanisms and contribute to the development of effective prevention and treatment methods.

Keywords: Road traffic accident, personal mobility devices, fractures, maxilla, mandible, combined and isolated injuries.

RELEVANCE. Recent research indicates a growing number of cranial bone injuries resulting from road traffic accidents. According to statistics provided by the Jamieson Institute of Traumatology, projections for 2024 show a continued upward trend. To support this forecast, the Jamieson Institute collected data from 30 emergency hospitals through the Queensland Injury Surveillance Unit (QISU). In 2022 alone, more than 1,000 injury cases were recorded, and by the end of May 2023, emergency departments had already registered 558 injuries resulting from road traffic accidents involving electric scooter use[1,3,5,9].

Observations from social media in Tashkent, Republic of Uzbekistan—specifically the official Instagram account of the law enforcement representative "press_qahramon"—reveal frequent use of electric scooters in unauthorized areas. Moreover, many electric scooter users are unfamiliar with traffic regulations, which significantly contributes to the risk of road traffic accidents[4,6,8].

INTRODUCTION. At the present time, there is a widespread increase in the use of personal mobility devices, particularly electric scooters. Due to global distribution and large-scale usage, there is an observed increase in road traffic accidents associated with this type of transport.
According to data obtained from official sources on road traffic accidents from the "Road Safety Service of the Department of Public Safety of the Ministry of Internal Affairs of the Republic of Uzbekistan," and taking into account the statistics of RTAs and the increase in reported indicators by the Road Safety Service, there is an observed rise in injuries in the maxillofacial region (MFR), especially in the upper and lower jaws[14,16].
This is caused by the pathological perception and distribution of the impact wave through the buttresses received during RTAs involving the use of electric scooters. Buttresses are thickenings of the bony plate that distribute masticatory load[2,12,15].
There are four buttresses in the upper jaw that participate in the even distribution of masticatory load, including:

- the frontonasal buttress,
- the zygomaticoalveolar buttress,
- the pterygopalatine buttress,
- the palatine buttress.

In the lower jaw, there are two buttresses:

- the ascending buttress and
- the alveolar buttress,

which are intended for the distribution of physiological load generated during the act of chewing.
When pathological exogenous impact is applied to the buttresses ("blows"), fractures are observed in specific locations where the bony plate has a less dense structure[1,4,7].

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RESEARCH OBJECTIVE. To determine the role of buttresses under external pathological impacts leading to fractures of the upper and lower jaws.

MATERIALS AND METHODS. The study was conducted at the Tashkent State Dental Institute and involved patients who sought professional medical and surgical care at the Department of Emergency Surgical Assistance for maxillofacial injuries (MFR). The study included patients with lacerations, abrasions in the head region, and fractures of cranial bones, particularly of the upper and lower jaws, with both combined and isolated injuries.

At the time of the study, the trajectory and distribution of deviations along the buttresses and their significance in the occurrence of injuries in the dentoalveolar system were examined. To determine the deviation of the impact wave, an experimental reconstruction of the moment of impact was carried out, including the force, speed, trajectory, the plane of impact, and the localization of the head area where the impact occurred.

A selection of materials ("props") was carried out, with the help of which the practical part of this study was conducted. As props, a cylindrical pipe was used — without edges, with a smooth surface, 1 meter in length, an outer diameter of 21.3 mm, and a wall thickness of 2.8 mm. Uneven ground with the presence of crushed stone (small-sized stones with numerous sharp edges) and road asphalt were also used — the asphalt was localized in a specific area and therefore was not included in the list of materials; as a result, the experimental setup was reproduced in different locations with various combinations[10]. These combinations included roadside ditches with a depth of 30 cm and a diameter of 40 cm, asphalt with an uneven surface, and asphalt with a smooth surface. Each prop was obtained by specific means. For example, the cylindrical pipe used for water and gas supply was purchased at a market in standard length and then cut to the required size of 1 meter.

It should be noted that if a piece of ground or asphalt is taken without regard to its size, the practical part of the study will yield unreliable experimental results. This is because cutting out a piece of ground or creating an artificial version of asphalt will not provide accurate indicators[11]. Referring to real-life events, the ground or asphalt used in the construction of optimal roads for the movement of personal mobility devices has significantly different properties. Moreover, the density characteristics of such roads cannot be artificially replicated[13]. Therefore, in order to recreate a simulated accident scenario arising from the use of devices belonging to the category of electric scooters, the experimenter made the decision to conduct the experiment in a specific location in the vicinity of the Tashkent State Dental Institute.

RESEARCH RESULTS

The results of the theoretical and practical parts of the study showed that, when an impact is received in the zygomatic region of the lateral surface, the deviation and distribution of the force occur in three directions:

The first type follows the zygomatic arch toward the temporal bone, with a fracture observed at the point of formation of the zygomatic arch — specifically, at the junction of the zygomatic process of the temporal bone with the temporal process of the zygomatic bone. This direction corresponds to the zygomaticoalveolar buttress[17,18].

The second type follows the apical arch passing at the level of the root apices. In this distribution, the fracture occurs along the same direction, starting from the maxillary tuberosity toward the lower part of the piriform aperture. This direction may lead to a combined fracture, such as an alveolar-horizontal fracture of the maxilla and a fracture of the orbital floor. In this scenario, the distribution of the impact wave is observed to begin from the zygomaticoalveolar buttress toward the frontonasal buttress, with deviation into atypical parts of the buttress system located in the orbital floor and the apical arch of the maxilla.

The third type follows the zygomatic bone toward the orbital floor.

In addition, during the experiment, impacts resulting from falls onto a flat surface from the frontal part of the head predicted possible fractures according to the Le Fort classification types I, II, and III, indicating the severity of the trauma. Furthermore, with minor trauma, nasal bone fractures were also possible.

Analyzing the distribution of the impact wave, the point of contact may be the body of the maxilla or the frontal process of the maxilla. In Le Fort I, the fracture line runs horizontally along the border between the alveolar process and the body of the maxilla, extending from the lower wall of the piriform aperture toward the maxillary tuberosity.

Other types of Le Fort fractures, depending on the severity and direction, are determined by the force and vector of the pathological impact on the cranial bones.

CONCLUSION

The severity and localization of a fracture are determined by the force of the impact, the trajectory of its distribution, the location of the initial point of contact, as well as the type of surface involved in the collision.

A direct contributing factor to the increase in maxillofacial injuries is the use of electric scooters, mopeds, and other types of personal mobility devices without proper knowledge of operation and in the absence of individual protective equipment.

Road incidents and related tragedies are often associated with underage children. Therefore, in order to reduce road traffic accidents, it is recommended to

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establish specific requirements and criteria for the purchase and use of personal mobility devices by minors, and to hold parents accountable in cases of violations of these requirements and criteria, with the aim of preventing maxillofacial injuries.

It should not be forgotten that, in addition to the cranial bones, the brain is located inside the skull. Moreover, numerous vascular networks pass through the head region, and damage to these structures can lead to fatal outcomes.

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