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Titanium Inclusions In The Soft Tissues Adjacent To The Fixators In Patients With Traumatic Injuries And Defects Of The Facial Bones

Trauma

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Objectives

To study microstructural changes on the surface of fixation elements, to determine the content and distribution of titanium and other chemical elements in adjacent soft tissues, as well as factors influencing these parameters in the long-term period following osteosynthesis of the facial bones.

Methods

Titanium fixators (plates and screws), removed in 12 patients in the long terms following osteosynthesis, as well as biopsy samples of the periosteum and fibrous capsule adjacent to the fixing elements were studied. Micro-X-ray fluorescence spectral analysis (M4TORNADO, Bruker, Germany) was used to determine the elemental composition of the removed soft tissue fragments. Scanning electron microscopy (JSM-6060 (Japan)) was used to study structural changes on the surface of titanium fixators. The obtained data were compared using the Spearman correlation test.

Results

In all cases, electron microscopy of fixation elements revealed signs of surface damage. Micro-X-ray fluorescence analysis detected local titanium deposition in all the studied samples with average titanium content of $48.14 \pm 31.1\%$ with two type of distribution. Areas with strictly limited intensive titanium inclusions (90.9-800um) and diffuse titanium inclusion without clear boundaries. Samples removed following osteosynthesis in patients with traumatic fractures, showed higher content of titanium in the deposition areas $55.6 \pm 29.4\%$ vs $37.72 \pm 30.2\%$ in patients with reconstructive interventions due to higher loading of the fixator. The analysis of the obtained data revealed no significant impact of the titanium content in tissues on the development of inflammatory complications and exposure of the plate ($r=0.465, p>0.05$), between the content of titanium and the duration of the period when the plate remained in the human body ($r=0.38, p>0.05$), between the content of titanium and the type of plate ($r=0.237, p>0.05$).

Conclusions

Titanium fixators interact with the surrounding biological environment (titanium particles were found in all investigated samples). The main mechanisms involved into release of titanium into the adjacent biological tissues are corrosion and mechanical damage.