HIGH-TECH TREATMENT METHODS IN POST-TRAUMATIC ARTHROSIS OF THE SHOULDER JOINT.

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ANNOTATION:

Post-traumatic arthritis of the shoulder joint, a condition following shoulder trauma, leads to chronic pain, reduced mobility, and progressive joint degeneration. Recent advancements in medical technology have introduced high-tech treatment methods that aim to improve recovery rates, alleviate symptoms, and enhance joint function. This article reviews these advanced techniques, highlighting their efficacy, applications, and potential for reducing the long-term impact of post-traumatic arthritis in shoulder joints.

Introduction. Post-traumatic arthritis occurs when a joint suffers from osteoarthritis due to previous injuries, such as fractures, ligament tears, or dislocations. The shoulder joint, one of the most mobile joints, is particularly susceptible to arthritis following trauma. Traditional treatments, including physical therapy, medication, and surgical interventions, may be insufficient for patients with severe damage or degeneration. High-tech treatment methods offer innovative solutions that improve outcomes by targeting the root causes of arthritis, reducing inflammation, and promoting regeneration.

Arthrodesis of the shoulder joint is a surgical intervention consisting of resection of the joint and fixation of the humerus to the scapula to form ankylosis, ensuring painless functioning of the upper limb in new anatomical and functional conditions.

Thirty years of experience in shoulder joint endoprosthetics has shown a low survival rate of modern systems, as a result of which in some cases after 7-12 years an inoperable condition from the point of view of endoprosthetics develops.

In case of contraindications to revision endoprosthetics of the shoulder joint in such patients, arthrodesis is increasingly required, which orthopedists, on the one hand, have begun to forget, and on the other hand, avoid due to the imperfection of traditional surgical technique, which turns out to be completely ineffective in the consequences of complications of shoulder joint endoprosthetics [3]. In addition, it has become clear that primary endoprosthetics is generally contraindicated for people engaged in heavy physical labor. The new reality has led to the search for other solutions to the problem of terminal arthropathies by reviving the operation of arthrodesis of the shoulder joint at a new technological level, which can ensure successful ankylosing in case of combined defects of the humeral head and articular process of the scapula. For this purpose, we modified the surgical technique and created a special internal fixator for the formation of an ankylosis standardized by the angles of installation [11].

In case of contraindications to endoprosthetics, this turned out to be a high-tech option for surgical restoration of upper limb function.

The aim of the work is to demonstrate the possibilities of the new methods of arthrodesis of the shoulder joint in the aftermath of complications of endoprosthetics and terminal arthropathies of the shoulder joint.

The new method and special internal fixator for forming ankylosis, standardized by the angles of the shoulder-scapular relationships, created at the R.R. Vreden National Medical Research Center of Traumatology and Orthopedics, are not only an updated option for surgical restoration of upper limb function for all known indications for shoulder arthrodesis, but also a highly effective method for contraindications to revision endoprosthetics. The device is a bridge-like structure that combines a scapular fixation unit in the form of a fork with locking screws for attachment to the scapular spine and a bone plate for fixing the diaphysis of the humerus.

For its external similarity, the device received the name called "tuning fork" [11]. The combination of proximal blocking and compression plate in the design provides rigid interfragment fixation, which resists loosening for a long time and maintains optimal mechanical conditions for consolidation of the humerus with the remnants of the articular process of the scapula in the absence of the head of the humerus.

The shape of the retainer includes such angles between the scapular blocking fork and the extraosseous diaphyseal part that, when fixed, set the optimal deflection and deviation

in the shoulder joint and correspond to the functionally advantageous position of the scapulohumeral ankylosis. They are responsible for the relative comfort of the patient and the achievement of a rational range of motion of the shoulder with the upper limb. The surgeon only needs to specify the rotational setting.

The bend along the contour of the humeral head allows one to bypass the resected remains of the proximal end of the humerus with the remains of the articular process of the scapula (Fig. 1a), orient their precise alignment, and free up space around the mating surfaces for the placement of transplants that increase local bone mass and completeness of contact. After removal of the prosthesis leg or spacer, there is always a high probability of delayed con solidification due to a decrease in the reparative potential of the adjacent bone. This requires that the fixator have long-term resistance to fatigue fractures of the structure at the level of the opening. Therefore, the transition zone of the fixator above the resected shoulder joint is made without openings that are stress concentrators. The scapular fixation unit is made so that when placed on the scapular spine, the fork of the "tuning fork" covers it with branches from the front, in the supraspinous fossa, and from behind, in the infraspinatus. Fixation is carried out with three or four lagscrews that pass through the scapular spine, block it and firmly clamp it, bringing together the branches of the fork (Fig. 1 b, c). Such fixation successfully resists loosening in the scapula and ensures reliable

compression for a long time. In the diaphyseal part of the plate there are three types of holes: a longitudinal groove for one-stage static compression by the contractor, oval compression holes for dynamic compression and round holes for final fixation of the humerus.

Technique of operation: The operation can be performed from two positions of the patient: the “beach lounger”, sitting with the torso raised, which is traditional for houlder surgery, or in the supine position.

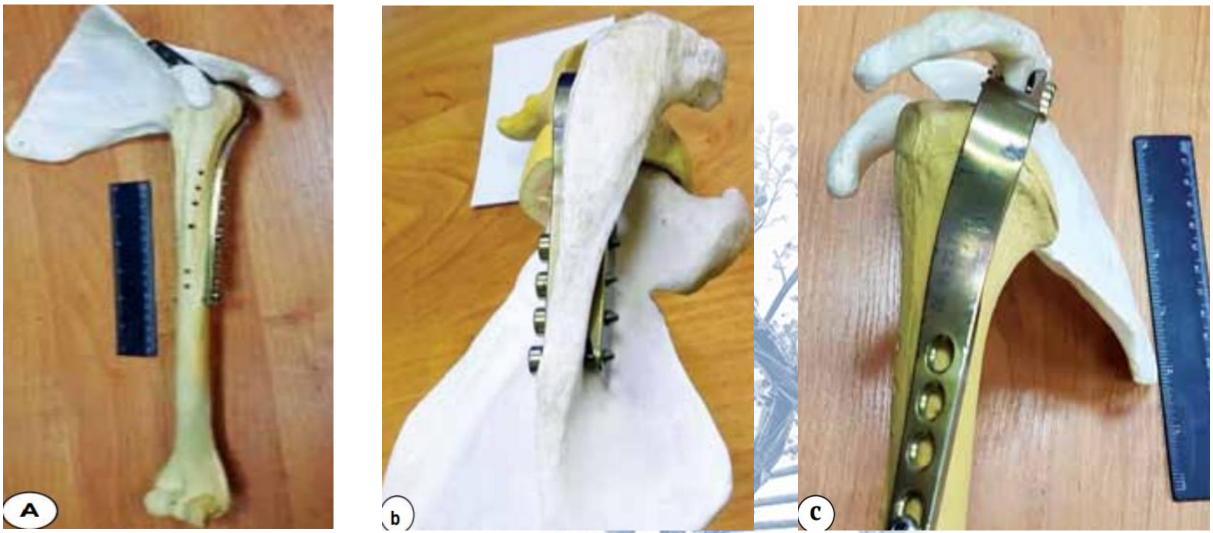

Fig. 1. The location of the fixator on the bone and the coverage of the scapular spine with locking screws on a model made of educational plastic bones:

a — general view; b — view from the side of the scapular spine; c — side view

Fig. 1. Location of the fixator on the bone and the coverage of the scapular spine with locking screws on a training plastic saw bone: ÿ — general view; b — view from the scapular spine; c — side view

Platelet-Rich Plasma (PRP) involves isolating growth factors from the patient's blood and injecting them into the affected shoulder joint. PRP has shown to accelerate healing, reduce inflammation, and support tissue regeneration. Studies indicate that PRP can be particularly effective in early to moderate cases of post-traumatic arthritis.

Stem Cell Therapy involves the use of mesenchymal stem cells (MSCs), commonly sourced from the patient’s bone marrow or adipose tissue. These cells are injected into the shoulder joint, where they can potentially differentiate into cartilage cells, supporting regeneration and reducing inflammation.

Minimally invasive arthroscopic surgery allows surgeons to repair damaged tissues within the shoulder with precision. In cases of post-traumatic arthritis, procedures may involve removing damaged cartilage or repairing torn ligaments, thus stabilizing the joint and slowing arthritis progression.

Computer-Assisted Surgery (CAS) and robotics enable greater accuracy during joint repairs and reconstructions. Real-time imaging techniques such as MRI or CT scans guide the surgeon, reducing complications and enhancing the precision of repairs.

PEMF therapy uses electromagnetic fields to stimulate cellular repair in damaged tissues. Research indicates that PEMF can promote anti-inflammatory effects and stimulate cartilage regeneration, which helps reduce pain and improve joint function in patients with arthritis. PEMF has been shown to be particularly effective for shoulder joints by enhancing the body’s natural healing processes.

For patients with significant joint damage, joint replacement with customized implants may be necessary. 3D-printing technology allows for the creation of implants specifically designed to match the unique structure of the patient's shoulder joint. Customized implants ensure better fitting, which can lead to improved outcomes and a reduced risk of joint dislocation or instability post-surgery.

AR and VR technologies are increasingly being used in post-operative rehabilitation to assist patients in improving shoulder mobility. These technologies allow patients to perform guided exercises in an engaging way, encouraging adherence to rehabilitation protocols. VR-based rehabilitation programs are particularly beneficial for shoulder mobility improvement, helping patients gain confidence in movement and monitor progress through real-time feedback.

Recent advancements in tissue engineering involve creating biological scaffolds that support the growth of new cartilage cells within the shoulder joint. Biological scaffolds, often seeded with stem cells or growth factors, serve as a framework for the regeneration of damaged cartilage. This method shows promise in restoring shoulder joint function and slowing the degenerative process.

Numerous clinical studies support the efficacy of these high-tech treatments in reducing pain, improving joint function, and potentially delaying or preventing the need for total shoulder replacement. For example, PRP and stem cell therapies have been reported to improve patient outcomes, with many experiencing decreased pain and increased range of motion. Computer-assisted and robotic-assisted surgeries have shown reductions in surgery time and post-operative complications, making them preferable options in complex cases.

While these high-tech treatment methods show promising results, challenges remain, including high costs, limited access to advanced technology in some regions, and variable patient responses. Further research is necessary to standardize protocols, optimize dosing and delivery for regenerative treatments, and improve long-term data on the outcomes of these procedures. However, with continued advancements, these high-tech solutions hold the potential to revolutionize the management of post-traumatic arthritis in the shoulder joint.

Conclusion.

High-tech treatment methods for post-traumatic arthritis of the shoulder joint offer a range of innovative solutions that complement traditional therapies. Techniques such as regenerative medicine, minimally invasive surgery, and digital rehabilitation tools provide new pathways for effective management, minimizing the need for invasive procedures, and improving patient quality of life. Future advancements in these high-tech methods will continue to enhance recovery outcomes for individuals suffering from shoulder arthritis following trauma.

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