



Current state of the treatment problem in the patients with elbow joint contractures due to ossification

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Abstract

Introduction Surgical treatment of stiff elbow caused by ossification often result in poor outcomes due to anatomical and physiological characteristics, significant functional load and higher patient requirements for the elbow functionality.

The purpose was to determine ways of improved surgical treatment for patients with elbow contractures caused by ossification, based on an analysis of literature reporting surgical strategy and outcomes.

Material and methods An internet search of PubMed, Medline, Elibrary.ru, CyberLeninka, Google Scholar, International Clinical Trials Registry of the US National Institutes of Health, ISRCTN Registry of International Standard Randomized Clinical Trial Numbers, German Clinical Trials Registry DRKS, WHO Registry was performed. Search words and phrases included elbow contracture, ossification, surgical treatment, stiff, elbow, surgical treatment, ossification. The search depth was 10 years.

Results and discussion Some important parameters (recurrence of stiffness, pain, decreased quality of life, etc.) are reported as “very unassertive” in patients with stiff elbow due to ossification at mid and long terms (12–24 months or greater). Poor outcomes are reported in approximately 50 % of the cases due to the range of motion decreased to the preoperative level or less. Many patients (more than 90 % according to some authors) need a repeated surgery and are at risk for the stiff joint.

Conclusion A critical analysis of the literature indicates lack of preoperative instrumentation examination of patients with use of new visualization methods (3D modeling). Preoperative examination and surgical planning based on additive technologies are essential for surgically treated patients with stiff elbow caused by ossification.

Keywords: elbow joint, contracture, ossification, surgical treatment, arthroscopy, manipulation under anesthesia/redressal, prosthetics, reconstructive plastic surgery, long-term results

For citation: Petlenko IS, Shubniakov II, Fedunina SYu, Aliev AG, Bilyk SS, Riabinin MV. Current state of the treatment problem in the patients with elbow joint contractures due to ossification. *Genij Ortopedii*. 2024;30(2):273-281. doi: 10.18019/1028-4427-2024-30-2-273-281

INTRODUCTION

Despite the improvements in surgical techniques and technology treatment of elbow contractures due to ossification remains one of the biggest challenges in trauma and orthopaedic surgery [1, 2]. Although traumatic injuries to the bones forming the elbow joint are not common and account for less than 5 % of all skeletal injuries [3], post-traumatic and postoperative complications occur in a third of patients (29.9 %) [4–7]. With this parameter, the elbow joint consistently ranks first, which often contributes to poor outcomes and persistent disability of patients, despite seemingly adequate treatment and rehabilitation [8]. Difficulties in management of the patients are associated with persistent contractures developing shortly after injury due to periarticular ossification [9]. The extremely high importance of the elbow joint in the human physiological activity leads to the fact that its stiffness, including that caused by ossification resulting from traumatic injuries, surgical interventions and diseases and other factors associated with this phenomenon often can lead to functional failure of the limb [10–13]. The range of motion in the elbow joint decreased by 50 % reduces the functional activity of the upper limb by 80 % [14]. Elbow contracture can limit individual's ability to work, perform household chores or participate in recreational activities [3, 8, 15, 16]. Repeated functional restorative surgical interventions can be required for 30 to 60 % of patients operated on for injuries or diseases of the elbow joint [17–19]. Heterotopic ossification (HO) of the elbow occurs frequently after mechanical damage to the joint, which is not typical and is extremely rare for other joints [3, 20, 21].

Rapid development of persistent elbow contractures due to the tissue's propensity for various types of ossification (including paraarticular) is a serious problem in the treatment of this target patient population [9, 22, 23]. The strategy of surgical treatment of the patients requires discussion and may need improvement, one of the options may be the use of New methods of preoperative examination and planning, based on current computer technologies can be applied to allow an accurate localization (for various types of ossification) and the severity of the pathological process [24].

The purpose was to determine ways of improved surgical treatment for patients with elbow contractures caused by ossification, based on the analysis of literature reporting surgical strategy and outcomes.

MATERIAL AND METHODS

An internet search of PubMed, Medline, Elibrary.ru, CyberLeninka, Google Scholar, International Clinical Trials Registry of the US National Institutes of Health, ISRCTN Registry of International Standard Randomized Clinical Trial Numbers, German Clinical Trials Registry DRKS, WHO Registry was performed. Search words and phrases included elbow contracture, ossification, surgical treatment, stiff, elbow, surgical treatment, ossification. Most publications corresponded to a search depth of 10 years. Single (fundamental) studies on the problem dated back to the 1990s. In addition to that the cited sources mentioned in the bibliographic sections of the articles and contained relevant information were used after preliminary examination.

A total of 186 thematic publications were identified, of which 81 articles published in Russian and 105 were foreign articles (mostly in English). With abstracts, patents, experimental studies, etc. being excluded the references reduced to 92. The review did not include articles on stiffness (contracture) of other joints, with the exception of articles reporting treatment of combined contractures of several joints of the upper limb, including the elbow. Articles published in languages other than Russian and English, as well as articles on elbow replacement due to contracture, were not used in this work. Literature sources reporting elbow stiffness caused by extra-articular causes, case reports and case series were not included in the review. Articles in full-text format and humans trials describing outcomes at mid term and/or long term were primarily included in the review.

Demographical data (gender and age of patients), the nosology, surgical techniques and assessment of mid-term and/or long-term outcomes of the patients were explored. New imaging methods (3D reconstruction of the joint based on computed tomography) are used preoperatively to improve the methodology of surgical treatment of patients with elbow contractures caused by ossification. In this regard, the review includes articles reporting the use of the (additive) technologies in different medical fields, including traumatology and orthopaedics, and the results of a patent search on this issue.

RESULTS AND DISCUSSION

Many authors emphasize that comparison of surgical outcomes of patients with elbow contractures, including those caused by ossification of different origin can be considered objective if the review includes data from one clinical center with surgical treatment performed using a single technology (standards of examination and treatment, and type 1 system errors) by the same specialists [25, 26]. In this regard, reviews and publications of retrospective studies on this issue are practical for assessing mid-term and/or long-term results of surgical treatment of contractures (including the elbow joint) [24, 25, 26].

Qian et al. reported the use of multivariable logistic regression analysis to evaluate long-term outcomes of 461 patients treated for elbow contractures and found that risk factors for progression of stiffness might include increased “cast immobilization time” (immediately after injury and following surgical procedure; OR = 2.020; $p = 0.014$), multiple surgeries (OR = 1.943; $p = 0.026$) and alcohol abuse (OR = 3.082; $p = 0.025$) [26]. Haglin et al. reported a retrospective record review of 103 patients with elbow contractures who underwent open surgical treatment (arthrolysis) of the joint. At the initial procedure, 85 % of patients “demonstrated elbow extension/flexion arc of motion of 100°”. A 19-to-24-month follow-up showed that 93.2 % (!) of the total cohort of cases required repeated surgical treatment for various reasons. Radiographic recurrence of HO occurred in 17 % after surgery. Not including recurrence of contracture, a subsequent complication occurred in 10 patients. The authors reported repeated operations being common including neurolysis of the ulnar nerve, debridement and use of drains for postoperative infection. The authors concluded that “patients must be counseled that contracture may reoccur, and some patients may require or elect to have more than one procedure to achieve functional motion” [24].

Spitler et al. explored the efficacy of repeated surgical interventions for recurrent elbow contractures [27]. Patients were stratified based on the duration of the time interval between primary and repeat surgical interventions. Patients who had repeat surgery within 3 months of their most recent surgical procedure ($n = 28$) were included in the “early manipulation” group. Patients who underwent repeat procedure after 3 months ($n = 17$) were included in the “late manipulation” group.

A comparative analysis of the improvement in elbow arc of in the study groups revealed clinical significance (the difference in the increase in the average arc of motion between the groups was $+38.5^\circ$ and $+3.1^\circ$ in the comparison groups, respectively) and statistically significant difference ($p \leq 0.001$) in favor of the early manipulation group. Other authors reported similar patterns in the treatment of patients [28]. A clinically significant increase in the amplitude ($+10^\circ$ or more) was detected in less than half of the cases of the late manipulation group. An average arc of motion decreased in approximately 30 % of patients (6 out of 19). Four patients required additional surgical treatment, and 2 of them developed clinically significant HO. The authors reviewed the long-term outcomes and the literature data and concluded that patients with osteogenic and heterotopic ossification were “unlikely to benefit” from such surgical treatment [29–33].

In addition to osteogenic ossification, which causes incongruity of the articular surfaces and requires simulating resection, the elbow joint can be susceptible to other types of ossification, such as myositis ossificans (MO) and HO [34]. Elbow contractures with these types of ossification are reported to occur in 10 % in MO and about 7 % in HO [34–36]. There is a paucity of therapeutic methods for elbow contracture due to ossifying processes. Conservative methods, methods of static and dynamic splinting and “manipulation under anesthesia”, redressment cannot be used for the target population of patients [37]. Surgical treatment is indicated for patients with elbow joint stiffness in presence of ossification [34, 38, 39].

Mittal concluded that the best results in the treatment of the condition can be achieved with the surgery performed within the first year of the contracture to prevent extra-articular factors aggravating the pathological process (muscle and tendon spasticity, decreased elasticity of the joint capsule due to chronic inflammation, etc.) [34, 40, 41]. Preoperative planning for repair of elbow contracture, including that caused by ossification, must address all the pathological structures and/or other factors that contribute to loss of mobility due to recurrent condition or complications [24, 42–44].

The role of preoperative planning in improving surgical strategy and treatment results

Osteophytes and calcification of soft tissues contributing to contractures often raise difficult questions for clinicians in terms of diagnosis, treatment, clinical and social rehabilitation and prognosis of the disease [9, 23]. is also The elbow joint is of greatest interest in this regard being prone to such pathological conditions [6, 22]. Accurate identification of the position and size of pathological bone structures in the preoperative period suggests more rational planning, minimal surgical aggression and better treatment results [8, 45, 46]. Standard radiological examination using several views is considered the main instrumentation examination used as the basis for preoperative planning. However, a two-dimensional image

can fail to show the exact size and location of ossifications. In addition to that, computed tomography (CT) can help “visualize joint structures much better”, and magnetic resonance imaging (MRI) is “rarely required when assessing elbow stiffness” [34].

Mellema et al. reported surgical treatment of elbow contracture with use of modern methods of three-dimensional reconstructions based on CT images for a more complete assessment of the articular and periarticular structures [25]. Objective results of surgical treatment of patients with elbow contractures of the joint due to improved examination strategy using modern computer technologies could not be found in the available literature. Most works in the Russian-language literature on the topic are theoretical and/or controversial [47–50].

Some works reporting additive technologies in traumatology and orthopaedics address aspects related to joint replacement [51, 52] or patient rehabilitation [53]. There is no universal surgical technique reported for treating elbow contractures, including those caused by ossification [37, 43, 46, 54–56]. Considering the tendency of this joint to overproduction and heterotopia of bone tissue, most authors agree that all surgical interventions should be performed with minimal surgical aggression [13, 24, 34].

It is quite obvious that conventional radiological examination and even MSCT of the affected joint, recommended as standards for preoperative examination of patients, do not provide a complete picture of the prevalence and severity of ossification and other pathological conditions [7, 8, 25, 26, 45]. The surgeon is forced to make decisions in the operating room during the operation resulting in increased operating time and numerous risks (including those contributing to the relapse of contracture), and contradicting the concept of minimal surgical intervention, reported in many works on the treatment of elbow contractures [7, 8, 20, 28, 34, 44, 45, 57, 58].

Analysis of literature data on the surgical treatment of patients with elbow contractures indicates that various types of ossification resulting from diseases and injuries, surgical interventions can lead to significantly impaired elbow function and contracture. Currently, surgical treatment of patients with elbow joint contractures due to ossification is somewhat reminiscent of a vicious circle. The surgical interventions (and re-operations, in particular) produced to remove ossification (arthroscopy, simulating resection of bone structures, excision of ossification foci) are one of the factors provoking the development of ossification. The high tendency of the elbow joint to develop stiffness is due to the specific anatomical structure. The presence of three separate joints within one capsule, the large number of periarticular nerve trunks, the abundance of vulnerable soft tissues necessary to provide joint stability, and the proximity of the brachialis muscle to the anterior capsule predisposes the joint to the development of contracture even with minor levels of alteration. With the arsenal of methods for treating elbow joint contractures, not all of them can be used in patients with various types of ossification. There is not enough clinical data to recommend a universal method for treating contractures caused by ossification, even from a relatively small arsenal of surgical methods. With a surgical intervention performed in a delayed manner (at 3 months or later after the development of contracture), a sufficient range of motion (about 4 %) can hardly be achieved intraoperatively and the range of motion

in the elbow joint decreases in some patients (about 30 %) after surgery. Recurrent condition is observed in approximately 17 % of patients with contractures caused by ossification after surgical treatment.

Most studies focus on the fact that there is no single protocol for surgical or combined treatment of patients with elbow contractures, and it is difficult to compare the results of studies. There is a paucity of information regarding preoperative planning and examination of patients using new imaging methods. Recommendations on this issue are usually limited to performing radiographs (in standard projections) or MSCT studies. A few studies contain references to the use of three-dimensional reconstructions based on CT images for a more detailed assessment of the articular and periarticular structures. An analytical review of literature data on the surgical treatment of patients with elbow contractures of the joint allows us to conclude that:

- surgery is the main treatment method for elbow contractures, including those caused by ossification to be performed with arthroscopic techniques or open access;
- each of the surgical techniques has advantages and disadvantages, and the treatment strategy would be differentiated in each specific case;
- mid-term and long-term results indicate a significant decrease in the range of motion in the operated joint below acceptable values in half of the patients;
- a significant number of patients operated on for contractures caused by ossification may require repeated surgical interventions due to the anatomy and physiology of the elbow joint, however, early repeated and delayed (later than 3 months) procedures are considered as risk factors for recurrent condition;
- surgical interventions for elbow contracture (in the presence of ossification, in particular) should be performed with minimal surgical aggression, since a surgical procedure in this case is a risk factor for recurrence of the disease and for an increased period of immobilization (after injury or surgery);
- authors pay little attention to preoperative examination of patients, but the use of additive technologies in the process of examining patients with elbow contractures, including those caused by ossification, can provide the most complete information about and are able to provide the most complete information about the condition of bone and articular and para-articular structures to be used for preoperative planning and surgical intervention to be performed with minimal surgical aggression and greater efficacy.

CONCLUSION

A critical analysis of the literature shows a paucity of information on preoperative examination of patients using new visualization methods (3D modeling). In our opinion, preoperative examination and planning based on additive technologies are essential for surgical treatment of patients with elbow contractures caused by ossification having a more significant role than that which was identified based on the analysis of literature data.

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The article was submitted 04.09.2023; approved after reviewing 19.12.2023; accepted for publication 21.02.2024.

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