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ORIGINAL ARTICLE

Impact of different glucose metabolism status on clinical outcomes of open arthrolysis for post-traumatic elbow stiffness

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Background: Diabetes and prediabetes are worldwide public health problems and are considered predisposing factors for adverse functional outcomes after various orthopedic operations. The purpose of this retrospective study was to determine the impact of glucose metabolism status on functional outcomes and complications after open arthrolysis for post-traumatic elbow stiffness.

Methods: The study included 152 patients with post-traumatic elbow stiffness undergoing arthrolysis, including 120 in the normoglycemic group, 21 in the impaired glucose regulation group, and 11 in the diabetes mellitus group. General patient data, functional performance, and complications were documented and analyzed.

Results: Demographic data and disease characteristics were comparable at baseline. Postoperatively, significant differences were found in range of motion and the Mayo Elbow Performance Score: the diabetes mellitus group had the poorest clinical outcomes. However, there were no significant differences in forearm rotation, visual analog scale pain scores, and complication rates.

Conclusion: Patients with post-traumatic elbow stiffness and abnormal glucose metabolism were at increased risk of poorer outcomes after open arthrolysis, and patients with diabetes mellitus had the poorest performance. This study underlines the importance of glycemic control in patients with abnormal glucose metabolism before open arthrolysis.

Level of evidence: Level II; Retrospective Design; Prognostic Study

Keywords: Post-traumatic elbow stiffness; open arthrolysis; different glucose metabolism status; diabetes mellitus; impaired glucose regulation; normal glucose tolerance; clinical outcomes

The Ethics Committee of Shanghai Jiao Tong University Affiliated Sixth People's Hospital concluded that no approval was necessary for this study based on its retrospective design. Data were analyzed anonymously; all patients approved the publication of the results of this study by oral consent. The oral consent approval was documented in the patients' files. This was approved by the Ethics Committee of Shanghai Jiao Tong University Affiliated Sixth People's Hospital. All clinical investigations were conducted in accordance with the guidelines of the Declaration of Helsinki.

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The functional arc of elbow motion during activities of daily living is reportedly 100° for both flexion-extension (30°-130°) and pronation-supination (50° in either direction).[17] Stiff elbow is a common complaint after trauma, with an incidence ranging from 3% to 20%.[12] Arthrolysis is indicated when patients have no further benefit from conservative therapy.[29] In most cases, arthroscopic techniques[3] are only preferred for simple elbow contractures based on Jupiter's classification.[13] Open arthrolysis is still the most common treatment method and has been shown to be effective, with a low incidence of complications.[4,15]

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It is estimated that 382 million persons worldwide have diabetes mellitus (DM), according to the International Diabetes Federation, and this number will increase to 592 million by 2035.[11] Surprisingly, the estimated prevalence of DM and prediabetes among a representative sample of Chinese adults was 11.6% and 50.1%, respectively.[32] It is well known that DM is characterized by progressive deterioration of glucose metabolism. Impaired glucose regulation (IGR), which is thought to place individuals at high risk of DM development according to the American Diabetes Association, is defined as the intermediate stage between normal glucose tolerance (NGT) and DM.[2] Because of defects in insulin action, secretion, or both, DM is characterized by hyperglycemia, with an obvious impact on skeletal tissue metabolism and osseous healing.[24] By delaying collagen synthesis and impairing wound healing, DM may lead to poorer clinical outcomes including reduction in range of motion (ROM), muscle strength, and ability to perform routine activities.[16] Several studies have focused on the effect of diabetes on upper limb surgery. Increasing risks of pneumonia, urinary tract infection, and cerebrovascular accident were reported in DM patients after total elbow arthroplasty,[28] in addition to non-homebound discharge and prolonged hospital length of stay.[21] Moreover, DM was identified as a predisposing factor for decreased efficacy of capsular release in the treatment of shoulder stiffness.[19]

The purpose of this retrospective study was to evaluate the clinical outcomes in patients with different glucose metabolism status who had post-traumatic elbow stiffness after open arthrolysis. Given the evidence that diabetes is a predisposing factor for increased complications and adverse functional outcomes after different orthopedic procedures, we hypothesized that abnormal glucose metabolism status would have a similar negative effect on outcomes after elbow arthrolysis.

Table I Demographic and clinical characteristics of patients

Characteristic	NGT	IGR	DM	*P* value
No. of patients	120	21	11	
Male	77 (64)	17 (81)	9 (82)	.185
Age, yr	36 ± 11	40 ± 13	41 ± 11	.11
BMI, kg/m^2	23 ± 3	23 ± 2	24 ± 2	.64
Dominant limb	75 (63)	12 (57)	8 (73)	.688
Disease duration, mo	23 ± 32	38 ± 75	18 ± 16	.369
Previous elbow ORIF	105 (88)	16 (76)	11 (100)	.15
Tobacco use	29 (24)	7 (33)	2 (18)	.578
Follow-up time, mo	22 ± 6	24 ± 10	26 ± 11	.548

NGT, normal glucose tolerance; *IGR*, impaired glucose regulation; *DM*, diabetes mellitus; *BMI*, body mass index; *ORIF*, open reduction and internal fixation.
Categorical variables are presented as number (percentage). Continuous variables are presented as mean ± standard deviation.

Table II Comparison of original injury types

Characteristic	NGT	IGR	DM
No. of patients	120	21	11
Simple elbow dislocation, n	10	2	0
Distal humeral fracture, n	42	9	5
Radial head fracture, n	17	1	2
Olecranon fracture, n	23	7	1
Coronoid fracture, n	4	0	1
Monteggia fracture, n	4	0	0
Floating elbow fracture, n	8	2	2
Terrible-triad injury, n	12	0	0

NGT, normal glucose tolerance; *IGR*, impaired glucose regulation; *DM*, diabetes mellitus.

Materials and methods

Patients

This was a retrospective case-control study that assessed patients who presented to our institution with elbow stiffness between January 2015 and August 2016. The inclusion criteria were (1) skeletally mature, (2) elbow stiffness with a total arc of flexion and extension of less than 100°, (3) caused by trauma, and (4) treated with open arthrolysis. The exclusion criteria were (1) follow-up time of less than 12 months, (2) prior elbow release, (3) associated with severe burns or central nervous system injuries, (4) associated nonunion or malunion of the elbow joint, (5) severe articular damage requiring joint arthroplasty, (6) receiving other elbow open reduction and internal fixation or second arthrolysis during the follow-up period, or (7) unwillingness to participate in the study. During the period of this study, 198 patients underwent surgery for elbow stiffness at our institution. Of these, 167 met the inclusion and exclusion criteria. However, 15 of 167 were excluded because of refusal or loss to follow-up. The remaining 152 patients were divided into 3 groups according to the 1999 World Health Organization diagnosis and classification criteria for DM,[1] with 120 in the NGT group, 21 in the IGR group, and 11 in the DM group. General patient demographic characteristics, including sex, age, body mass index, dominant limb, and tobacco use, were recorded. The following baseline clinical data were also collected: disease duration, treatment history, follow-up time, original injury type, ROM, visual analog scale (VAS) score for pain, and Mayo Elbow Performance Score (MEPS). Original injury type included simple elbow dislocation, distal humeral fracture, radial head fracture, olecranon fracture, coronoid fracture, Monteggia fracture, terrible-triad injury, and floating elbow fracture. Motion of the injured elbow was assessed with a goniometer. The MEPS is a widely used elbow functional evaluation system assessing pain, ROM, stability, and activities of daily living. Scores are classified into 4 categories: excellent, 90-100; good, 75-89; fair, 60-74; and poor, 0-59. Improvement in ROM (ΔROM, postoperative ROM – preoperative ROM) and improvement in the MEPS (ΔMEPS, postoperative MEPS – preoperative MEPS) were also calculated. At follow-up, postoperative complications, including new onset or exacerbation of ulnar nerve symptoms, reduced muscle strength, elbow instability, and infection, were evaluated. Ulnar nerve symptoms were evaluated according to the Dellon classification.[8] Stress and pivot-shift tests were performed to assess elbow stability.[18] At the last follow-up, postoperative data were also collected (Tables I-V).