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Evaluation of the Davos self-assisted technique for reduction of anterior glenohumeral dislocations: a comparative study with the traction/countertraction technique

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Background: Few studies have compared conventional and self-assisted shoulder reduction maneuvers. The goal of this study was to evaluate the results of self-assisted Davos vs. traction/countertraction (T/Ct) techniques in the treatment of acute anterior shoulder dislocations.
Methods: This was a single-center, prospective study carried out at a tertiary hospital emergency department. Patients aged 18-69 years old, with radiographic confirmation of anterior glenohumeral dislocations, were consecutively allocated to treatment groups. Recorded data included pain at admission (visual analog scale [VAS] score at admission), analgesia before reduction, maximum pain during reduction (maximum VAS score), demographic characteristics, lesion mechanism, laterality, prior dislocation, and immediate complications. The primary outcomes were reduction success rate and pain.
Results: Eighty individuals were included (40/group). Regarding the success rate, no statistically significant differences were found between Davos or T/Ct (87.5% vs. 85%; $P = .058$). The maximum VAS score was significantly lower in Davos than that in T/Ct (4.18 ± 2.00 vs. 6.30 ± 2.13; $P < .001$). The effect of analgesia in the maximum VAS score was more evident among Davos patients, with significantly lower pain in the subgroup who were provided analgesia (3.63 ± 2.02 vs. 5.31 ± 2.01; $P = .01$).
Discussion: Davos was as effective as T/Ct for reduction of acute anterior shoulder dislocations (highest reported success rate: 87.5%) and conditioned a less traumatic experience, with significantly lower pain during reduction (the maximum VAS score was more than 2 points lower in the Davos group; $P < .001$). Analgesia had a synergistic effect among patients submitted to the Davos technique, suggesting that T/Ct is inherently more painful.
Conclusion: The Davos is a patient-controlled, atraumatic, and safe technique, allowing successful, gentle, and less painful glenohumeral reduction. These findings favor Davos as an easy-to-teach and effective first-line treatment for first-time and recurrent shoulder dislocations.

The glenohumeral joint is the most mobile joint of the human body, making it more prone to instability.[20] Shoulder instability is a relatively common orthopedic problem, and the initial presentation is often a glenohumeral joint dislocation.[16,19,25] Most dislocations are anterior in direction and may affect both young, physically active patients (with significant upper extremity demands and greater risk for acute traumatic glenohumeral instability events) and older, low-demand patients, conditioning different treatment options and prognosis.[5,10,16,19,25]

Acute shoulder dislocation represents a surgical emergency, demanding urgent relocation. Closed reduction is usually the first-line of treatment, either for an initial episode or for recurrent cases.[17] Since Hippocrates first described his closed reduction maneuver, numerous techniques and variants have been proposed to relocate the humerus to its glenoid socket.[1,8,17] Many techniques

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share common features, which may include physician-assisted upper limb traction and/or rotation, leverage techniques, or scapular manipulation.[1,9] Despite high success rates, many of these techniques are associated with high scores of pain and discomfort, as well as iatrogenic injuries (proximal humerus fractures and/or neuropraxia).[7,21,23]

Self-reduction techniques are alternatives that allow patients to reduce a dislocated joint, enabling self-care and pain relief when medical facilities are not nearby, while preventing delays in reduction that may be associated with lower success rates.[15,22] Although some patients are able to easily relocate their joint into position because of hyperlaxity, recurrent episodes, or voluntarily instability, most are impaired by pain, loss of function, and/or lack of information on how to reduce their shoulder.

The Davos method (also named Boss-Holzach-Matter or Aronen technique) was first described in 1993 as an atraumatic and analgesic-free reduction method, with a 60% success rate.[4] Further studies reported success rates up to 86%, with very low complication rates.[6,22,27] Notwithstanding the potential benefits and advantages of this technique, studies with a high level of evidence are missing to compare its effectiveness and safety with other conventional techniques.

The goal of this study was to evaluate the results of a self-assisted Davos technique vs. a conventional traction/countertraction (T/Ct) method, through a prospective study of patients with acute anterior shoulder dislocations.

Materials and methods

We carried out a single-center, prospective study in which all acute anterior shoulder dislocations treated in the emergency department of a tertiary referral hospital, starting in October of 2016, were assessed for eligibility. Patients with radiographic confirmation of anterior glenohumeral dislocations, aged 18-69 years old and willing to participate, were included. Patients were excluded from enrollment if any of the following criteria were present: previous surgery to the affected shoulder, chronically unreduced glenohumeral dislocation, acute nonanterior glenohumeral dislocation, associated fracture(s), or inability to follow the physician's instructions.

We conducted a pre-hoc power analysis to estimate the minimal required sample necessary to detect a 1.5-point difference on a 0- to 10-point visual analog scale (VAS) at a 2-tailed α of 0.05 and with a power (1-β) of 0.85. As per our calculations, our sample size should include 80 patients, resulting in 40 patients in each treatment group (Davos or T/Ct reduction techniques). Through consecutive sampling, we allocated patients to one of the two treatment groups. The first 40 eligible patients were submitted to the Davos technique, and afterward, 40 consecutive eligible patients were included in the control group, to whom a conventional T/Ct method was applied. After assessment of predefined inclusion and exclusion criteria, oral consent to participate in the study was obtained from the patients.

Pain at admission to the emergency department was immediately recorded using the VAS (VAS score at admission). Decision on analgesia was made during initial evaluation based on patients' complaints, following institutional analgesic protocols. Closed reduction was performed as per treatment group allocation. After completion and confirmation of shoulder reduction, the need for analgesia before reduction, as well as the maximum level of pain during the maneuver (maximum VAS score), was recorded, by an independent and blinded physician. An unsuccessful reduction attempt was defined as (1) a case requiring a second, different reduction maneuver, (2) reduction under sedation, or (3) open reduction.

Figure 1 Traction/countertraction maneuver. The patient is placed on his/her back with a folded sheet around the chest to provide countertraction; the physician stands on the side of the dislocated shoulder and provides traction to the arm with the shoulder in abduction as the assistant applies firm countertraction; gentle internal and external rotation is sometimes required to disengage the head.

Our primary outcomes in analysis were reduction success rate (confirmed with plain radiography) and pain (experienced at patients' admission to the emergency department and the maximum level of pain during the glenohumeral reduction maneuver). Additional data included demographic characteristics, mechanism of lesion, laterality, existence of prior ipsilateral dislocation, and immediate complications. By January 2019, we completed the sample of 80 patients who met the inclusion criteria and agreed to participate in the study. The study received institutional ethics committee board approval.

Reduction techniques

The T/Ct maneuver (Fig. 1) was used as the “conventional” physician-guided method of closed reduction. In this maneuver, commonly performed in our department, the patient is placed on his/her back with a folded sheet around the chest to provide countertraction; the physician stands on the side of the dislocated shoulder and provides traction to the arm with the shoulder in abduction as the assistant applies firm countertraction; gentle internal and external rotation is sometimes required to disengage the head.[1,12]

The Davos technique (Fig. 2) was selected as the self-assisted method to be performed by the patient under the guidance of a physician. In this reduction maneuver, the patient is seated on a hard surface, flexes the ipsilateral knee to 90°, and places the foot flat on the surface; with the fingers interlocked about the knee, the hands are tied together using an elastic bandage, preferably at the wrist level (not at the fingers), so that the patient can be more relaxed and does not have to concentrate on keeping the fingers crossed; the patient gently leans backward with the neck hyperextended until the arms are fully extended, producing axial traction; simultaneously, the patient shrugs the shoulders anteriorly, generating scapular anteversion on the axis of traction to facilitate glenohumeral reduction.[4,6,27] After sharing the technique description and performing a brief demonstration of the Davos maneuver to the members working on the emergency department, all

Figure 2 The Davos technique. The patient is seated on a hard surface, flexes the ipsilateral knee to 90°, and places the foot flat on the surface; with the fingers interlocked about the knee, the hands are tied together using an elastic bandage, preferably at the wrist level; the patient gently leans backward with the neck hyperextended until the arms are fully extended, producing axial traction; simultaneously, the patient shrugs the shoulders anteriorly, generating scapular anteversion on the axis of traction to facilitate glenohumeral reduction.

participating staff felt comfortable in performing the Davos maneuver.

Statistical analysis

Statistical analysis was performed using IBM SPSS statistics, version 25 (IBM Corp., Armonk, NY, USA). Study data were summarized using descriptive statistics (mean, standard deviation, frequency, percentage). The t-test, the Mann-Whitney U test, and the Kruskal-Wallis H tests were used to compare quantitative variables between both groups, and the chi-square test was used to analyze categorical data. A P value of <.05 was considered significant.

Results

In total, 80 individuals were included. The mean age was 36.8 ± 17.0 years old. There was a male predominance (n = 64; 80%), and in 55% (n = 44) of all cases, it represented the first episode of glenohumeral dislocation of the involved limb. The left shoulder was slightly more frequently involved (n = 44; 55%). Numerous mechanisms of injury were identified: spontaneous dislocation was the most frequently reported (n = 21; 26%), closely followed by low-energy trauma (n = 20; 25%), such as a fall from own height or low-impact traumatism; 15 patients (19%) suffered glenohumeral dislocation related to sports or recreational injury, and 9 patients (11%) reported a work-related accident. Table I summarizes the baseline characteristics of the overall sample, while providing a comparison between the 2 treatment groups. No statistically significant differences regarding age, gender, laterality, or recurrent dislocation were found between Davos and T/Ct groups. Throughout the study, no acute complications were recorded for either treatment group.

Table II presents the results for the main variables analyzed, by treatment group. Regarding success rate, no statistically significant differences were found between patients treated with either T/Ct or Davos technique (85% vs. 87.5%, respectively; P = .058). Overall, there were 11 unsuccessful reduction cases (as summarized in Table III). In the Davos group (n = 5), all occurred in patients with a first episode of shoulder dislocation, whereas in the T/Ct group, 4 of 6 failures occurred in patients with first-time dislocation. However, there were no statistical differences in the VAS score at admission or the maximum VAS score between first-time and recurrent dislocation groups (neither in the general study population, nor among unsuccessful reduction cases).

The analysis of reported pain (presented in Table II) revealed no statistically significant differences in terms of the VAS score at admission between both treatment groups (P = .49). However, the maximum VAS score was significantly lower in patients submitted to Davos self-reduction than that in patients submitted to T/Ct (4.18 ± 2.00 vs. 6.30 ± 2.13; P < .001), with a discrepancy greater than 2 points in the VAS score.

A similar number of patients in both treatment groups were provided analgesia before the reduction maneuver: 72.5% in the T/Ct group and 67.5% in the Davos group (P = .626). The analysis of the impact of analgesia on pain control revealed differing results as per the technique (as depicted in Table II), with analgesics being more effective in pain control during reduction (maximum VAS score) in the Davos group, compared with the T/Ct group. On the one hand, there was no statistically significant decrease in the maximum VAS score in the T/Ct group, whether analgesia was provided or not previously to reduction (6.28 ± 2.24 vs. 6.36 ± 2.23; P = .91). Conversely, in the Davos group, the maximum VAS score was significantly lower in the subgroup of patients who were provided analgesia (3.63 ± 2.02 vs. 5.31 ± 2.01; P = .01). Furthermore, the maximum VAS score among patients in the analgesic-free group was moderately lower in the Davos group than that in the T/Ct group (5.31 ± 2.01 vs. 6.36 ± 2.23; P = .330), and among patients who were provided analgesia, there was a significantly lower maximum VAS score in the Davos group than in the T/Ct group (3.63 ± 2.02 vs. 6.28 ± 2.24; P < .001).

Discussion

To the best of our knowledge, this is the first prospective study comparing the results of the Davos technique with the T/Ct maneuver, as well as the comparative study with the largest sample size. We report a high success rate for the Davos technique and lower pain during shoulder reduction (maximum VAS score) in patients submitted to the Davos technique, when compared with the T/Ct maneuver. In our series, the success rate of the Davos technique was 87.5%, similar to the widely used T/Ct technique (85%; P = .058). Moreover, our Davos technique success rate was slightly higher than that described in previous studies.[22,27]

The Davos maneuver conditioned a less traumatic experience for the patient. The maximum VAS score in the Davos group was more than 2 points lower than that reported in the T/Ct group (P < .001). This decrease is greater than the minimal important difference for patient-reported outcome measures in shoulder conditions, estimated at 1.5 points in the VAS.[13]

Besides, analgesia had a relevant complementary and synergistic effect among patients submitted to the Davos technique (a maximum VAS score of 3.63 ± 2.02 in Davos patients who received analgesics vs. 5.31 ± 2.01 in Davos "analgesic-free" patients; P = .01), but no significant impact in the T/Ct group. The effect of analgesia was evident, suggesting its effectiveness in pain relief during the Davos maneuver. Moreover, these results may suggest that the T/Ct technique is inherently more painful.

We believe that the lower pain reported and the higher response to analgesics in the Davos group may be attributable to the patient's active participation and to the forceless effort of the procedure. Because the Davos technique represents a patient-centered approach, it allows optimal individual participation and muscular relaxation through a simple communication routine, thereby minimizing pain, anxiety, and muscle contraction and increasing the patient's ability to cooperate as he/she is in control during all the reduction process.[2,18]

Although there are rare reports of acute complications associated with shoulder dislocation/relocation,[7,21,23] in our series, there were no immediate neurovascular or musculoskeletal

Table I
Baseline characteristics of the study population and treatment groups (Davos and traction/countertraction).

	Total (n = 80)	Davos (n = 40)	T-Ct (n = 40)	*P* value
Age (years)*	36.8 ± 17.0	35.6 ± 17.1	37.9 ± 17.12	.549
Gender†				
Male	64 (80%)	33 (82.5%)	31 (77.5%)	.576
Female	16 (20%)	7 (17.5%)	9 (22.5%)	
Laterality†				
Right-sided	36 (45%)	20 (50%)	16 (40%)	.369
Left-sided	44 (55%)	20 (50%)	24 (60%)	
Number of episodes†				
First dislocation	44 (55%)	20 (50%)	24 (60%)	.369
Recurrent dislocation	36 (45%)	20 (50%)	16 (40%)	
Mechanism of lesion				
Sports injury	15 (19%)	7 (17.5%)	8 (20%)	.303
Spontaneous dislocation	21 (26%)	14 (35%)	7 (17.5%)	
Work-related	9 (11%)	2 (5%)	7 (17.5%)	
Low-energy trauma	20 (25%)	13 (32.5%)	7 (17.5%)	
Other mechanism‡	15 (19%)	4 (10%)	11 (27.5%)	

T/Ct, traction/countertraction.
*The values are given as the mean and standard deviation.
†The values are given as the number of patients with the percentage in parentheses.
‡Mechanism not classifiable into any other category.

Table II
Main outcomes at analysis in the study population and treatment groups (Davos and traction/countertraction).

	Total (n = 80)	Davos (n = 40)	T/Ct (n = 40)	*P* value
Success rate*	69 (86%)	35 (87.5%)	34 (85%)	.058
VAS score†				
At admission	7.06 ± 1.45	6.95 ± 1.52	7.18 ± 1.39	.49
Maximum VAS score during reduction	5.24 ± 2.31	4.18 ± 2.00	6.30 ± 2.13	<.001
Analgesia before reduction*	56 (70%)	27 (67.5%)	29 (72.5%)	.626
Maximum VAS score during reduction†				
Without analgesia	5.50 ± 2.45	5.31 ± 2.01	6.36 ± 2.23	.330
With analgesia	5.13 ± 2.26	3.63 ± 2.02	6.28 ± 2.24	<.001

T/Ct, traction/countertraction; *VAS*, visual analog scale.
*The values are given as the number of patients with the percentage in parentheses.
†The values are given as the mean and standard deviation.

Table III
Comparison of unsuccessful reduction cases between first-time and recurrent dislocations.

	First dislocation (n = 9)	Recurrent dislocation (n = 2)	*P* value
Davos*	5	0	.455
T/Ct*	4	2	
VAS at admission†	6.78 ± 1.39	7.00 ± 2.83	.904
Maximum VAS†	6.00 ± 1.80	6.5 ± 3.54	.804

T/Ct, traction/countertraction; *VAS*, visual analog scale.
*The values are given as the number of patients.
†The values are given as the mean and standard deviation.

complications, suggesting that the Davos technique is safe for shoulder reduction, as reported in other studies.[22,27]

As only few studies have compared the efficacy, reliability, and safety of the various techniques, it is largely left up to the health care provider to determine which maneuver is best on a multifactorial, patient-to-patient basis.[2,3,9,24] T/Ct is familiar to most physicians, and it is the technique primarily used by emergency department physicians of this institution (ensuring homogenization of the series with regard to the procedure). Moreover, its efficacy has been proved, and it has been used as a comparative/control group in studies evaluating the efficacy of other reduction techniques.[11,12,26,28] The Davos technique is described as a safe, atraumatic, and patient-controlled self-reduction maneuver for glenohumeral dislocations. Its reported effectiveness ranges between 60% and 86%.[4,6,22,27] However, to the best of our knowledge, only two prospective studies have assessed its effectiveness, and in only one of these studies, a comparative analysis between Davos and Spaso maneuvers had been performed.[6,22]

In this study, the Davos technique was conducted by several members of the orthopedics emergency department, including residents. Although variability may limit reproducibility, the high success rate (87.5%) suggests that the Davos technique can be safely and reliably performed, as long as the patient is adequately instructed and is willing to follow the physician's instructions. Moreover, the easiness and effectiveness of this self-reduction technique may allow it to be easily translated to the prehospital settings (such as sports competitions and/or schools) with minimal training, optimizing the patient's care, particularly when medical staff or facilities are not available.

A few limitations can be identified. First, this is a single-center study. Second, a nonprobability sampling method was used. Despite being cost- and time-effective, it may induce selection bias,

reducing our ability to make valid inferences to the entire population.[29] However, our statistical analysis did not reveal significant differences between treatment groups regarding demographic variables, and our study population is similar to that described in previous studies about shoulder dislocation.[19,22] No statistically significant differences were found between first-time and recurrent dislocations regarding the VAS score at admission and the maximum VAS score ($P = .309$ and $P = .685$, respectively), suggesting that the confounding effect of recurrence in our sample is negligible. This study sample was relatively young (mean age, 36 years old), which may limit the conclusions for older groups, as both dislocation characteristics and patients' compliance may differ. Finally, time from the beginning of the maneuver to adequate reduction was not registered. This may be controlled and evaluated in future studies, to strengthen our main findings.[14]

Conclusion

The Davos technique is a patient-controlled, atraumatic, and safe technique, allowing successful glenohumeral reduction (with no statistical difference between Davos or T/Ct techniques regarding the reduction rate), in a gentle and less painful way. Its simplicity of use and easiness to learn make the Davos technique a useful tool for patients with first-time and recurrent dislocations seen in the emergency department. This maneuver may eventually be taught to the general population as an effective means of reducing acute glenohumeral dislocations.

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