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Reduction of Acute Anterior Dislocations: A Prospective Randomized Study Comparing a New Technique with the Hippocratic and Kocher Methods

By Fares E. Sayegh, MD, Eustathios I. Kenanidis, MD, Kyriakos A. Papavasiliou, MD, Michael E. Potoupnis, MD,
John M. Kirkos, MD, and George A. Kapetanos, MD

*Investigation performed at Third Orthopaedic Department, Aristotle University of Thessaloniki Medical School,
"Papageorgiou" General Hospital, Thessaloniki, Greece*

Background: There are several methods to reduce anterior shoulder dislocations, but few studies have compared the efficacy, safety, and reliability of the different techniques. As a result, deciding which technique to use is seldom based on objective criteria. The aim of the present study was to introduce a new method to reduce an anterior shoulder dislocation, which we have termed "FARES" (Fast, Reliable, and Safe), and to compare it with the Hippocratic and Kocher methods in terms of efficacy, safety, and the intensity of pain felt by the patient during reduction.

Methods: Between September 2006 and June 2008, a total of 173 patients with an acute anterior shoulder dislocation (with or without a fracture of the greater tuberosity) were enrolled in the study. One hundred and fifty-four patients, who met all inclusion criteria, were randomly assigned to one of the three study groups (FARES, Hippocratic, and Kocher) and underwent reduction of the dislocation by first or second-year orthopaedic surgery residents. A visual analog scale was used to determine the intensity of the pain felt by the patient during reduction.

Results: Demographically, the groups were comparable in terms of age, male:female ratio, the mechanism of dislocation, and the mean time between the injury and the first attempt at reduction. Reduction was achieved with the FARES method in 88.7% of the patients, with the Hippocratic method in 72.5%, and with the Kocher method in 68%. This difference was significant, in favor of the FARES method ($p = 0.033$). The mean duration of the reduction maneuver was significantly shorter for the FARES method (2.36 ± 1.24 minutes for the FARES method, 5.55 ± 1.58 minutes for the Hippocratic method, and 4.32 ± 2.12 minutes for the Kocher method; $p < 0.001$), and the mean visual analog pain score was significantly lower for the FARES method (1.57 ± 1.43 for the FARES method, 4.88 ± 2.17 for the Hippocratic method, and 5.44 ± 1.92 for the Kocher method; $p < 0.001$). No complications were noted in any group.

Conclusions: The FARES method is a significantly more effective, faster, and less painful method of reduction of an anterior shoulder dislocation in comparison with the Hippocratic and Kocher methods. It is easily performed by only one physician, it is applicable to anterior shoulder dislocations as well as simple fracture-dislocations, and its use is associated with no more morbidity than that associated with the other two methods.

Level of Evidence: Therapeutic Level I. See Instructions to Authors for a complete description of levels of evidence.

Anterior dislocations of the glenohumeral joint are very common¹. There are several methods of reduction of the anterior dislocation of the shoulder, including those introduced by Hippocrates, Kocher, Milch, and Stimpson. The rates of success and complications fol-

lowing reduction vary according to the method used^{1,2}. Although most anterior shoulder dislocations can be easily reduced in the emergency department of most hospitals, some dislocations still require the implementation of more than one method, and in 5% to 10% of cases, reduction can

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only be achieved in an operating room with the patient under anesthesia^{2,3}.

The optimum method of reduction should require minimum assistance for the physician performing it, and it should be highly effective, quick, safe, and relatively painless². Because there have been few studies in the literature that have compared the efficacy, safety, and reliability of different reduction techniques, choosing which method to use is difficult if objective criteria are to be considered².

The aim of the present study was to introduce a new method of reduction of an acute anterior dislocation of shoulder (which may or may not be accompanied by a fracture of the greater tuberosity) and to provide an objective comparison of this new method with the Hippocratic and Kocher methods in terms of efficacy, safety, and the intensity of pain felt by the patient during reduction.

Materials and Methods

The present prospective randomized study was approved by our institution's scientific research board, and it was conducted in accordance with the World Medical Association Declaration of Helsinki of 1964 as revised in 1975 and 2000. The present study was registered in a public trial registry (Current Controlled Trials ISRCTN80984121). All patients were informed about their participation in the study and gave informed consent.

Between September 2006 and June 2008, 173 patients with a "first-time" traumatic anterior dislocation of the shoulder (with or without an associated fracture of the greater humeral tuberosity) were referred to the accident and emergency department of our hospital (which is a tertiary trauma referral center) and were enrolled in the present study (Table I, Fig. 1). The exclusion criteria included dislocation associated with

a three or four-part fracture of the proximal part of the humerus, a duration of dislocation of more than twenty-four hours, intoxication (as we wanted patients to be able to cooperate when undergoing reduction in order to eliminate bias against any one method), and the use of analgesics and/or muscle relaxants before attempting reduction.

The present study was of a randomized, parallel-group construction. Randomization was based on tables of random numbers. The clinical diagnosis of the dislocation was further confirmed on the basis of a physical examination and the findings on standard anteroposterior and transthoracic radiographs of the shoulder. Following the diagnosis, all patients who met the inclusion criteria were randomized to undergo reduction of the dislocation with one of the three methods used in the study: the new "FARES" (Fast, Reliable, and Safe) method, the Hippocratic⁴ method, or the Kocher⁵ method. The Hippocratic and Kocher methods were chosen mainly because they were familiar to all of the physicians participating in the study. Furthermore, a brief audit of the case notes on all patients with an anterior dislocation of the shoulder that had been reduced at our hospital prior to the study revealed that these were the two most frequently used methods, with the Hippocratic method being used in 58% of all cases and the Kocher method being used in 21% of all cases. All reductions were performed without sedation, anesthesia, or pain control by one of three first or second-year resident orthopaedic surgeons who had attended a brief instructional course prior to involvement in the study.

After each reduction, the physician who performed the reduction completed a standard detailed history concerning the demographic data on the patient and a brief medical history. The mechanism of injury, the time interval between the injury and the first attempt at reduction, the duration of the

TABLE I Baseline Characteristics of Patients Managed with Three Different Methods of Reduction

	Method of Reduction		
	FARES (N = 53)	Hippocratic (N = 51)	Kocher (N = 50)
Age* (yr)	41.2 ± 17.8	46.2 ± 15.4	43.7 ± 14.1
Sex (no. of patients)			
Men	43 (81.1%)	41 (80.4%)	37 (74%)
Women	10 (18.9%)	10 (19.6%)	13 (26%)
Dislocation (no. of patients)			
No fracture	45 (85%)	46 (90.2%)	44 (88%)
Greater tuberosity fracture	8 (15%)	5 (9.8%)	6 (12%)
Mechanism (no. of patients)			
Sports activity	10 (18.9%)	12 (23.5%)	13 (26%)
Car accident	12 (22.6%)	8 (15.7%)	13 (26%)
Fall	31 (58.5%)	31 (60.8%)	24 (48%)
Time interval*† (hr)	2.7 ± 2.6	2.2 ± 1.7	2.2 ± 1.5

*The values are given as the mean and the standard deviation. †Between the dislocation and the attempt at reduction.

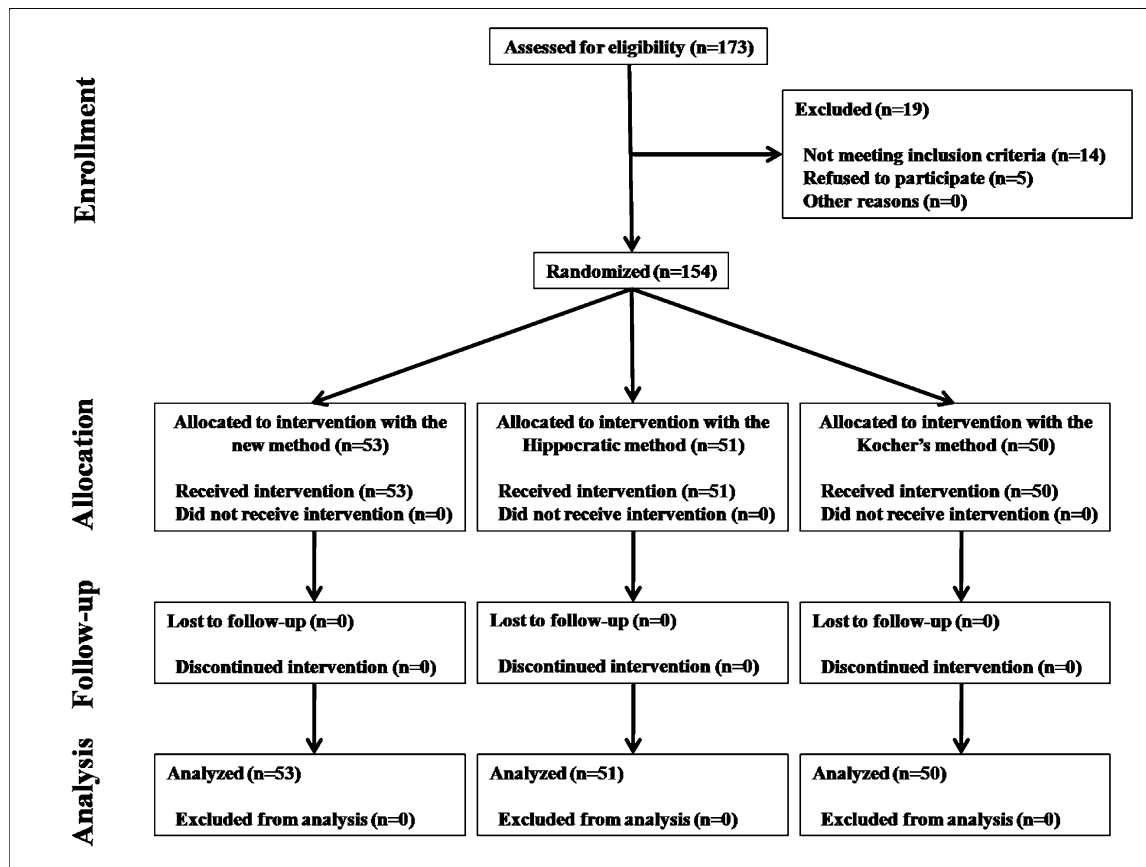


Fig. 1
CONSORT (Consolidated Standards of Reporting Trials) flow sheet.

reduction, the number of attempts to reduce the dislocation, and the existence of complications after the reduction were all registered. Each physician was allowed to apply the same method of reduction twice; after that, the reduction was characterized as unsuccessful. According to the instructions of the scientific research board at our institution, further attempts to reduce a shoulder dislocation without sedation were not allowed and all patients with a dislocation that was not successfully reduced underwent further treatment under general anesthesia. The physicians who performed the reduction or reductions in the operating theater (all of whom were consultant orthopaedic surgeons) were free to choose any method of reduction, regardless of the study group to which each patient belonged. Following successful reduction of the dislocation, each patient was asked to rate the amount of pain that he or she felt during each reduction attempt with use of a visual analog scale (with 0 points representing no pain and 10 points representing intolerable pain).

Statistical Analysis

The determination of the necessary sample size was made according to the reported efficacy of different methods in previous studies. Taking into consideration the fact that the efficacy of several methods of reduction has been reported to

range between 70% and 96%^{6,7} and that no minimum clinically important difference concerning reduction of the anterior shoulder dislocation has previously been published, our statistical analysis showed that, with a sufficient power of 0.8 and an alpha value of 0.05, in order to see a difference of 12% (the approximate middle of the reported range of 26%) between equivalent groups, at least forty-eight patients had to be enrolled in each of the three arms of the study. Standard statistical methods were used for descriptive statistics. The normality of the data distribution among different groups was tested according to the Kolmogorov-Smirnov and Shapiro-Wilk tests. All statistical tests were two-tailed. The alpha level for all analyses was set at 0.05. A chi-square test was performed to compare the effectiveness of the three different methods of reduction. The Kruskal-Wallis test was used to determine the significance of the differences found in the mean reduction time and the mean magnitude of the pain that was felt during reduction among patients in each of the three study groups. The Mann-Whitney test was used to compare the mean duration of reduction and the mean intensity of the pain that was felt during the reduction between the patients managed with the FARES and the Hippocratic methods, the FARES and the Kocher methods, and the Hippocratic and Kocher methods.

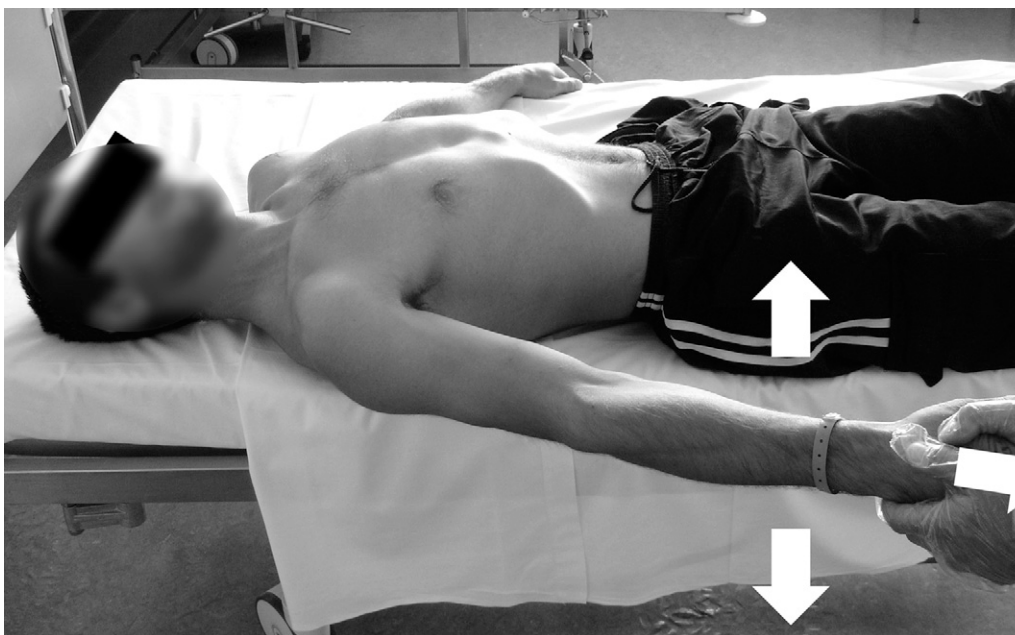


Fig. 2

The physician holds the patient's hand while the arm is at the side, the elbow is extended, and the forearm is in neutral rotation. Next, the physician gently applies longitudinal traction and slowly moves the arm into abduction. Continuously performed, brief (two to three full "cycles" per second), and "short-range" (approximately 5 cm above and beneath the horizontal level) vertical oscillating movements accompany all stages of the reduction.

Reduction Techniques

All reductions were performed with the patient lying on the back. When the reduction is performed with use of the new FARES method, the patient must feel as relaxed and comfortable as possible. No sedation or analgesics were used. The physician performing the reduction stood at the side of the affected extremity, facing the patient. The physician held the hand of the patient while the arm was at the side, with the elbow extended and the forearm in neutral rotation. Next, the physician applied gentle longitudinal traction and slowly moved the arm into abduction (Fig. 2). No countertraction was employed with this method of reduction. Continuously performed, brief (two to three full "cycles" per second), and "short-range" (approximately 5 cm above and beneath the horizontal level) vertical oscillating movements accompanied all stages of reduction as a means of muscle relaxation. Past 90° of abduction, the arm was gently externally rotated while abduction and the vertical oscillations were continued (Fig. 3). Reduction was usually achieved at around 120° of abduction (Fig. 4). Once reduction was achieved, the arm was gently internally rotated in order to bring the forearm to lie across the chest (Fig. 5).

The Hippocratic⁴ method was performed with the injured arm being placed in slight abduction. A downward traction force was then exerted by the surgeon performing the reduction (accompanied by slight rotational movements when needed) while an assistant exerted countertraction by holding a sheet wrapped around the patient's chest and under the patient's axilla and pulling it toward the patient's contralateral shoulder.

The Kocher⁵ method was performed with the elbow flexed to 90° and the arm then pressed (adducted) against the side of the body. After that, the forearm was slowly rotated outward until resistance was felt (at around 75°) and then it was lifted forward in the sagittal plane as far as possible. Finally, reduction was achieved by internally rotating the arm.

Source of Funding

There was no external funding source in support of this study.

Results

Five of the initial 173 patients withdrew their consent, and fourteen did not meet all inclusion criteria. One hundred and fifty-four patients (121 men and thirty-three women) were available for randomization. The mean age (and standard deviation) was 43.6 ± 15.9 years. The FARES method was used for fifty-three patients, the Hippocratic method was used for fifty-one, and the Kocher method was used for fifty (Fig. 1). The number of patients enrolled in each group reached the precalculated target that was necessary in order to reach secure conclusions. The three groups were demographically comparable in terms of age, male-to-female ratio, the mechanism of dislocation, the presence or absence of a coexisting fracture of the greater tuberosity, and the mean time interval between the injury and the first attempt at reduction (Table I).

The majority of the patients (87.7%; 135 of 154) had an anterior dislocation of the shoulder that was not accompanied by a humeral fracture. The mechanism of injury is shown in

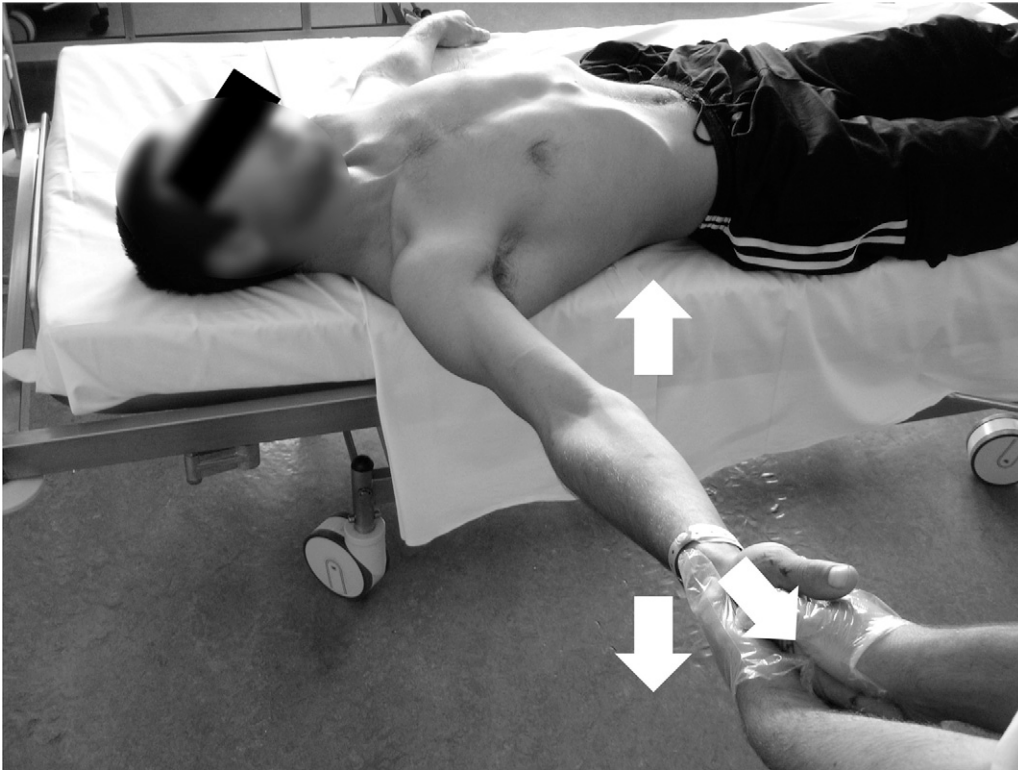


Fig. 3

Past 90° of abduction, the arm is gently externally rotated while abduction and the vertical oscillations are continued.



Fig. 4

Reduction is usually achieved at around 120° of abduction.



Fig. 5

Once reduction has been achieved, the arm is gently internally rotated in order to bring the forearm to lie across the patient's chest.

Table I. The time interval between the shoulder dislocation and the first attempt at reduction ranged from thirty minutes to sixteen hours (mean, 2.4 ± 2.02 hours). No complications were noted following the reduction in any of the patients.

Reduction was achieved with the FARES method in forty-seven (88.7%) of fifty-three patients, with the Hippocratic method in thirty-seven (72.5%) of fifty-one patients, and with the Kocher method in thirty-four (68%) of fifty patients. This difference was significant, in favor of the FARES method ($p = 0.033$) (Table II). Thirty-six patients, including six patients (five men and one woman; mean age, 39.3 years) from the FARES group, fourteen patients (twelve men and two women;

mean age, 43.2 years) from the Hippocratic group, and sixteen patients (thirteen men and three women; mean age, 40.6 years) from the Kocher group underwent closed reduction of the dislocation under general anesthesia in the operating room. The FARES method was used for fifteen patients, the Hippocratic method was used for nine, the Kocher method was used for eight, and the Milch method was used for four. All reductions that were performed in the operating room were successful on the first attempt, no complications were noted, and no patient required an open reduction.

Reduction was significantly faster with the FARES method as compared with the other two methods ($p < 0.001$, Kruskal-

TABLE II Efficacy, Time Needed for Reduction, and Pain Felt During Reduction

	Method of Reduction			P Value
	FARES (N = 53)	Hippocratic (N = 51)	Kocher (N = 50)	
Reduction result (no. of patients)				0.033*
Success	47 (88.7%)	37 (72.5%)	34 (68%)	
Failure	6 (11.3%)	14 (27.5%)	16 (32%)	
Reduction time† (min)	2.36 ± 1.24	5.55 ± 1.58	4.32 ± 2.12	<0.001‡
VAS pain score†§	1.57 ± 1.43	4.88 ± 2.17	5.44 ± 1.92	<0.001‡

*Chi-square test. †The values are given as the mean and the standard deviation. ‡Kruskal-Wallis test. §VAS = visual analog scale.

Wallis test) (Table II). The statistical comparisons between the FARES and Hippocratic methods, the FARES and Kocher methods, and the Hippocratic and Kocher methods showed that reduction was significantly quicker with the FARES method than with the other two methods ($p < 0.001$, Mann-Whitney test). Furthermore, the Kocher method was faster than the Hippocratic method ($p < 0.001$).

The pain that was felt during the reduction (as reported and graded by the patients) ranged from 0 to 9 points (mean, 3.92 ± 2.5 points) on the visual analog scale (Table II), and it was significantly milder when the reduction was performed with the FARES method ($p < 0.001$). Additional statistical analysis showed that the pain that was felt during the reduction was significantly milder even when the FARES method was compared separately with each of the other two methods ($p < 0.001$). The Kocher method was more painful than the Hippocratic method, but this difference was not significant ($p = 0.167$).

Discussion

An anterior shoulder dislocation can be reduced by several specific manipulations^{2-4,8,9}. The new FARES method that has been introduced in the present study is a combination of continuous traction with oscillation of the limb. It is true that the FARES method seems quite similar to the original Milch⁸ method; however, there are clear differences between the two. With the Milch method, the surgeon places his or her hand on the patient's shoulder in a way that the surgeon's thumb is braced against the dislocated humeral head². With the FARES method, both of the surgeon's hands hold the patient's hand and continuous traction is applied, without the use of countertraction. Furthermore, with the FARES method, the patient's arm is externally rotated after it has reached 90° of abduction, whereas with the Milch method, the arm is simultaneously abducted and externally rotated² or is just abducted (as originally described by Milch⁸). The application of continuous vertical oscillation on the arm (as a means to achieve muscle relaxation) while it is being abducted is another difference.

Several studies have evaluated the efficacy of different methods of reduction of anterior dislocation of the shoulder. The success rate associated with the Kocher method has been reported to be as high as 90%^{2,5,7,10}. In the present study, the Kocher method, when applied without sedation, had an efficacy of 68%. Scapular manipulation^{6,11}, external rotation¹², and the Milch method¹³ were also efficient, especially when sedation was used. The number of studies comparing the efficacy of one technique with that of another is even smaller^{3,6,10-12,14-16}. In the only randomized trial of which we are aware, Beattie et al.⁷ showed that the Kocher method was slightly more successful than the Milch method (77% compared with 75%) with the inclusion of first and second attempts; however, this difference did not reach significance. Compared with all of the above-mentioned techniques, the new FARES method appears favorable. The success rate (88.7%) is among the highest reported in the literature. The efficacy of this method is even greater when we consider that the method was evaluated without use of

sedation or analgesia and that it was performed by physicians who lacked extensive experience.

We tried to objectively determine which of the three methods was the most effective. The number of patients who had to be enrolled in each group was predetermined, the patients were properly randomized, and the three groups were demographically comparable at baseline. Furthermore, the method of reduction that was used was not decided by the physician performing the reduction. Apart from evaluating the efficacy of the new FARES method of reduction, the present study also demonstrated that this method of reduction was significantly faster than the other two methods, although speed may well be considered as a secondary objective when attempting to reduce an anterior dislocation of the shoulder. The use of the visual analog scale demonstrated that the FARES method was also significantly less painful.

However, the present study has some limitations as well. The most important limitation is the fact that the study was unblinded; nonetheless, this was more or less unavoidable considering the nature of the study. Another limitation is the fact that patients were not examined in order to detect instances of generalized ligamentous laxity that certainly could have influenced the ease and speed of reduction. As the patients were randomly assigned to any one of the three study groups and the physicians were blinded to the possibility that a patient had ligamentous laxity, this source of bias should have been equally distributed among the groups. Another limitation is the fact that only three methods of reduction were compared, and it is possible that another method may be similarly effective. It is also possible that the differences between the reduction methods would be eliminated if sedation were employed.

It should be noted that although the FARES method is currently being used with success by us, far larger numbers of patients are necessary in order to definitely determine its safety and efficacy. The reader should also be aware of the fact that the statistical determination of the necessary sample sizes was based on the potentially arbitrary setting of the threshold of significance between the three different reduction methods at 12%¹⁷. This threshold was our best estimate as there have been few studies in the literature^{6,7} comparing the efficacy of two methods of reduction, and none of those studies have been prospective and randomized. Furthermore, to the best of our knowledge, no minimum clinically important difference concerning the reduction of an anterior shoulder dislocation had previously been published.

In conclusion, the new FARES method was found to be significantly more effective, faster, and less painful (without the use of any analgesics or muscle relaxants) for the reduction of an anterior glenohumeral dislocation in comparison with the Hippocratic and Kocher methods. Furthermore, the FARES method can be performed by physicians with limited experience after a brief training session, is quite simple, does not require the presence of any assistants, appears to be safe, and has not been accompanied by any short-term complications. It also can be used effectively when an

anterior shoulder dislocation is accompanied by a fracture of the greater tuberosity. ■

Fares E. Sayegh, MD
“Papageorgiou” General Hospital,
Ring-Road, Nea Efkarpiā,
546 03 Thessaloniki, Greece

Eustathios I. Kenanidis, MD
7 Anoikseos Street, 570 10 Thessaloniki, Greece.
E-mail address: kena76@otenet.gr

Kyriakos A. Papavasiliou, MD
3 Natalias Mela Street,
546 46 Thessaloniki, Greece

Michael E. Potoupnis, MD
65 Olinthou Street,
543 51 Thessaloniki, Greece

John M. Kirkos, MD
138 Al. Papanastasiou Street,
542 49 Thessaloniki, Greece

George A. Kapetanos, MD
8 25th Martiou Street,
552 36 Panorama, Thessaloniki, Greece

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