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A Pilot Study of Inhaled Low-dose Methoxyflurane to Support Cunningham Reduction of Anterior Shoulder Dislocation

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Abstract

Aim: The Cunningham method allows for the reduction of anterior shoulder dislocations (ASD) without procedural sedation and analgesia (PSA) in some patients. This pilot study evaluates the feasibility of investigating whether the administration of inhaled methoxyflurane (I-MEOF) increases the success rate of Cunningham reduction of ASD.

Materials and Methods: Twenty patients with uncomplicated ASD underwent reduction attempts using the Cunningham method supported by I-MEOF analgesia (Cunningham/I-MEOF). Outcomes included the success rate without the requirement for PSA, emergency department length of stay (LOS), and operator and patient satisfaction.

Results: Of the patients enrolled. 80% were male, median age was 38.6 years (range 18-71) and 55% were the first dislocations. 35% (8/20 patients) were successfully reduced using Cunningham/I-MEOF. The remainder of patients proceeded to successful closed reduction under PSA. 60% of operators reported good to excellent satisfaction with the process. Operators identified the primary cause of failed initial reduction attempts as inadequate muscle relaxation. 80% of patients reported good to excellent satisfaction. Patients whose initial reduction attempt with Cunningham/I-MEOF was successful had an average LOS of 149 min, compared with 216 min for those who proceeded to reduction under PSA.

Conclusion: Success with ASD reduction by the Cunningham technique was marginally increased with the use of I-MEOF, although 65% of patients still required PSA to facilitate reduction. Both providers and patients found the process generally satisfactory, suggesting that early administration of analgesia is appreciated.

Keywords: Methoxyflurane, Cunningham, reduction, shoulder, dislocation

Introduction

Shoulder dislocations comprise 60% of major joint dislocations, 95% of these being anterior shoulder dislocations (ASD) (1). ASD is a medical emergency; treatment involves the reduction to a normal anatomical position as soon as possible, to manage pain and disability and to minimize the chance of poor long-term outcome. It has been reported that from the time of arrival in the emergency department (ED) with an ASD, every 10 min delay in the reduction attempt increased the odds of a failed reduction attempt by 19% (2).

Numerous methods exist to effect reduction (3), most of which are conducted under procedural sedation and analgesia (PSA) that allows the shoulder muscles to relax so that they do not hold the humeral head in a dislocated position. PSA involves administrating intravenous sedatives and narcotic analgesics that carry the risk of respiratory depression and hypotension (4). In the specific population of patients with ASD, the successful reduction of the dislocation to its normal position, immediately removes the painful stimulus that had antagonized the respiratory depression of the sedative and analgesic agents; often resulting in an unopposed respiratory depression that might be unrecognized

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as the crisis appears to have been solved with the restoration of the anatomy of the shoulder joint. The process of PSA thus requires both time and human resources to conduct, with specific expertise of caregivers skilled in the use of the medications and in the resuscitation and support of people who unexpectedly experience adverse events (4).

An ability to reduce even a portion of ASD humanely and efficiently without PSA would be a great advantage to the field of emergency medicine.

Several novel reduction methods for ASD have been described. One such method, the Cunningham technique (5,6) entails the massaging of the shoulder muscles in an attempt to get sufficiently relaxation to painlessly allow reduction without the inconvenience and risks of PSA. Unfortunately, although the method can work, and has been associated with decreased need for PSA, use of the Cunningham method has been limited by success rates as low as 27% (6). Moreover, although described as painless, it is not always so (7) which further limits its routine use. After unsuccessful attempts using the Cunningham technique, the fallback is generally to then provide PSA, increasing the time, and potential pain involved before eventual reduction.

Inhaled methoxyflurane (I-MEOF) offers a rapidly administered, minimally invasive option for short-term analgesia, and has been used to assist shoulder reduction (8). It has also been shown to decrease the length of stay within the ED and provide effective pain relief for patients (9). This pilot study evaluated the feasibility of investigating whether I-MEOF analgesia improves the process and success rate of ASD reduction using the Cunningham method.

Materials and Methods

At the Charles V. Keating Emergency and Trauma Centre, an academic ED where specially trained critical care paramedics are responsible for administering PSA (4), a consecutive sample of 20 patients, identified as having suffered an uncomplicated ASD was given the option of a first reduction attempt using the Cunningham method supported by I-MEOF analgesia (Cunningham/I-MEOF). Emergency physician operators, all of whom had had shown a series of videos demonstrating the Cunningham reduction method, were instructed to limit their initial reduction attempt to the Cunningham method. No other analgesics were used in the initial attempt. The attempt was considered successful if the reduction was achieved within 15 minutes and no other reduction methods, adjuvant analgesics or intravenous PSA were administered. If the reduction was not achieved, standard PSA was conducted. Outcomes measured at the time of discharge included initial success rate, subjective patient and operator satisfaction with the procedure on a scale of 1-5, with 5 representing 'excellent' satisfaction and 1 being 'poor', and ED length of stay (LOS) measured as time from initial registration to discharge from the ED. Institutional ethics approval was obtained. The study was supported by an unrestricted grant from Perdue Pharma, makers of I-MEOF (Penthrox^{R}).

Statistical Analysis

We recorded percentages of patients who achieved successful reduction under I-MEOF and those that subsequently received reduction under PSA.

Results

Twenty patients with ASD were approached, and all gave informed consent for a trial of a reduction attempt with Cunningham/I-MEOF. 80% were male, with a median age of 38.6 years (range 18-71). 60% were first-time dislocations. The Cunningham/I-MEOF approach was successful in 35% (7/20 patients), with a slightly better success rate in patients who had suffered a previous ASD (0.42 vs. 0.33). The remainder (13/20) proceeded to closed reduction under PSA (individual patient outcomes displayed in Table 1).

All patients had eventual successful closed reduction of ASD in the ED. 60% of operators reported good to excellent (4-5/5) satisfaction with Cunningham/I-MEOF, with inadequate muscle relaxation identified as the primary cause of failed initial reduction attempts. 80% of patients reported good to excellent (4-5/5) satisfaction with the process, although this decreased from 100% in successful cases to 69% for those proceeding to PSA.

Patients whose initial reduction attempt with Cunningham/I-MEOF was successful had an average and median ED LOS of 149 and 120 min, respectively, versus 216 and 178 min for those who proceeded to reduction under PSA. In the 12 months before this study, 169 patients presented with shoulder dislocations, with an average and median LOS of 229 and 186 min, respectively.

Discussion

Reported success rates with the Cunningham technique are low. Even with the addition of I-MEOF analgesia, our success rate of 35% was only marginally better than the 27% reported by Gudmundsson and Bjornsson (6). Although success was not significantly improved by adding I-MEOF, the Cunningham/I-MEOF approach was generally satisfactory for both providers and patients, suggesting that the early administration of analgesia for ASD is appreciated. Moreover, one-third of patients achieved atraumatic reduction using this approach and did not require PSA and in patients who did subsequently require PSA, 69% still

Table 1. Individual patient demographics and outcomes

Age	Gender	Previous ASD	Cunningham/I-MEOF success	Patient satisfaction of procedure	Reducer's opinion of procedure	LOS (min)
65	M	Yes	No	Very good	Poor	214
63	F	No	No	Excellent	Very good	117
18	M	No	Yes	Very good	Very good	201
58	F	No	No	Good	Good	361
68	F	No	No	Excellent	Excellent	164
21	M	No	No	Very good	Fair	153
28	M	Yes	Yes	Very good	Very good	81
44	M	No	No	Excellent	Good	94
20	M	No	Yes	Excellent	Excellent	238
21	M	Yes	No	Fair	Poor	120
32	M	Yes	No	Very good	Poor	108
30	M	No	No	Fair	Poor	282
50	F	Yes	No	Poor	Poor	134
27	M	No	Yes	Very good	Excellent	2.88
21	M	Yes	No	Very good	Very good	2.97
21	M	Yes	Yes	Excellent	Excellent	2.00
24	M	Yes	Yes	Good	Excellent	113
20	M	No	Yes	Excellent	Excellent	118
68	M	No	No	Fair	Fair	582
71	M	No	No	Excellent	Fair	199

ASD: Anterior shoulder dislocations, I-MEOF: Inhaled methoxyflurane

reported good to excellent satisfaction. Although we found a higher incidence of success in those with previous ASD (0.42 vs. 0.33), our numbers are too small to conclude in this regard.

The LOS for patients successfully reduced with Cunningham/I-MEOF was 67 min shorter compared to those subsequently requiring PSA. As the LOS in the latter group included the initial reduction attempt under I-MEOF, we also compared LOS in patients with ASD treated in the 12 months before the study period. The average LOS for study patients who required PSA was 13 min shorter than that for patients treated in the previous year. This finding is likely explained by the Hawthorne effect as study enrollment likely improved ED flow for all patients with ASD. Similarly, the LOS for patients with successful Cunningham/I-MEOF reductions may also have been shorter simply because they were enrolled in a study.

In a retrospective chart review, Umana et al. (8) reported that 30 of 152 patients with ASD underwent a reduction attempt using I-MEOF with a success rate of 80%, and a shorter LOS for those successfully reduced with I-MEOF. In their study, the selection of analgesia (I-MEOF or propofol), as well as the reduction technique, was at the discretion of the attending EP. The high success rate reported with I-MEOF-facilitated reductions is likely because EPs could identify and select patients less likely to require PSA (20% of all patients with ASD in their study). 16% of patients presenting during their study period achieved ASD reduction under I-MEOF, suggesting a greater opportunity to avoid PSA had they applied a first attempt at I-MEOF-assisted reduction to all patients (5).

One reason for the limited application of ASD reduction attempts without PSA may be concerned about exposing patients to unnecessary pain. Our findings suggest that the use of I-MEOF appears to manage the pain of reduction attempts even when they are subsequently found to be unsuccessful. Our findings suggest that an attempt at atraumatic reduction under I-MEOF is a reasonable first step in managing ASD.

Another inhalational analgesic that has been described for ASD reduction is nitrous oxide (NO). A study published in 2011 showed the successful reduction of only 10% of the cases using NO compared to 80% with PSA. The use of NO was also associated with increased side effects (80% vs. 8.4% with PSA) and a significant decrease in patient satisfaction (10).

Study Limitations

The aim of this pilot study was to test the feasibility of studying this approach to ASD reduction, and our findings are limited by the small sample size, the specification of a single atraumatic method and a non-randomized study design, which allows for the possibility of a significant placebo effect. Our findings should not, therefore be considered definitive evidence. The Cunningham method was selected because it is most familiar to EPs in our ED. There may have been a significant variation in operator comfort and experience with this method, which may have affected our success rate. Published experience with this technique is limited and some authors have expressed concern that the method is not as painless as initially reported. It is possible that different atraumatic reduction methods (11-13) assisted by I-MEOF may be more successful.

Larger, randomized studies may identify patient characteristics that make the Cunningham technique and other atraumatic reduction methods more likely to be successful. Further studies may also determine whether I-MEOF can be used to facilitate the reduction by methods previously believed to require PSA.

Conclusion

The addition of I-MEOF analgesia to the Cunningham method for reducing ASD does not appear to increase success rates, although the pain of unsuccessful attempts appears to be well controlled. The use of I-MEOF to support the first attempt at ASD reduction appears reasonable and does not seem to increase ED LOS.

Ethics

Ethics Committee Approval: The study was approved by the Nova Scotia Health Authority Research Ethics Board (protocol number: 1024125, date: 15.04.2019).

Informed Consent: Consent form was filled out by all participants.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: S.C., H.W., R.F., C.C., S.T., P.H., A.S., Concept: S.C., C.C., A.S., Design: S.C., A.S., Data Collection or Processing: S.C., H.W., R.F., C.C., S.T., P.H., A.S., Analysis or Interpretation: S.C., H.W., R.F., C.C., S.T., P.H., A.S., Literature Search: S.C., C.C., A.S., Writing: S.C.

Conflict of Interest: No conflict of interest was declared by the authors.

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