

Fluid gain during routine shoulder arthroscopy

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The objective of this study was to assess the physiological impact of fluid gained during routine shoulder arthroscopy. Included in this study were 40 consecutive patients undergoing an arthroscopic procedure of the shoulder. The weight, hemoglobin, hematocrit, and physiologic observations were compared pre- and postsurgery and correlated to the duration of the procedure and the amount of fluid used. The mean operative time was 27.4 minutes (± 11.2) with a mean fluid use of 3.2 liters (± 2.2). There was a mean weight gain of 0.9 kg ($\pm .64$, 0-3.2, $P < .0001$) and a mean drop in hemoglobin and hematocrit of 0.6 g/dl ($\pm .5$, 0-2, $P < .0001$) and 1.5% ($\pm 1.5\%$, 0-6%, $P < .0001$), respectively. There was a strong correlation between the amount of fluid used and the weight gain ($R = .89$, $P < .0001$). Although serious complications from fluid absorption during shoulder arthroscopy are rare, there is a significant absorption of irrigation fluid during the procedure. The time taken and the amount of fluid used should be kept to the minimum required for safe completion of the procedure. (J Shoulder Elbow Surg 2008;17:415-417.)

Arthroscopic shoulder operations are common practice in most hospitals. Little is known about the physiologic changes that occur associated with fluid accumulation in the soft tissues around the shoulder and associated absorption into the systemic circulation. Procedures, such as arthroscopic subacromial decompression, can expose the intramedullary vascular system and damage multiple small vessels during the operation. Arthroscopic fluid is usually pressurized to dilate the joint or bursa and aid in visualization by preventing bleeding from the microvasculature. It has been previously suggested that this pressure should be maintained at 49 mm Hg or less below the systolic blood pressure to preserve the clarity of the view.⁶ The pressure in both the supraspinatus

and deltoid muscle has been shown to rise up to 100-120 mm Hg during arthroscopy,^{7,8} and the amount of arthroscopic fluid used can be great. By having an elevated pressure and using a significant amount of irrigation fluid, there is potential for absorption of this fluid into the systemic circulation. This could lead to changes in the circulatory physiology of the patient, and to detrimental effects, especially in the elderly. Rapid intravenous infusion of 2 liters of normal saline has been shown to reduce the hemoglobin and hematocrit by 7.5% at 1 hour in healthy individuals.⁵

Therefore, the aim of this study is to evaluate the changes in the blood physiology by comparing the hemoglobin, hematocrit, weight, respiratory rate, blood pressure, and pulse prior to and 1 hour after the procedure. The cohort of patients represents the workload of a shoulder surgeon in a general hospital environment.

MATERIALS AND METHODS

During a period of 3 months, 40 consecutive patients undergoing shoulder arthroscopy were entered into the study. No selection criteria were made, and every patient during this time period was enrolled in the study. Each patient was seen preoperatively 2 weeks prior to surgery and routine full blood count was taken. The preoperative FBC was taken 2 weeks prior to the operation in order to avoid any hemoconcentration associated with fasting on the day of the operation. On admission, the patient was weighed in their surgical gown and routine observations were recorded.

One consultant surgeon or a registrar, under the supervision of the consultant, performed all the operations. All procedures were performed under a regional scalene block with or without general anaesthesia, and the anaesthesiologist administered 1 liter of Hartman's solution routinely to all the patients during the procedure. The patient was placed in a beach chair position with the arm in traction. Normal saline irrigation fluid was used under a controlled pressure of 50 mm Hg. Occasionally, if visualization was poor, the pressure would be increased to 70 mm Hg until the bleeding could be controlled. The time taken for the procedure and the amount of fluid used were recorded. Each incision was dressed with steri-strips, mepore, and a pressure dressing; the extremity was placed in a sling.

Once the patient arrived in the recovery ward, routine observations were made and a FBC taken at 1 hour postoperatively. The patient was also reweighed on the same scale before urination or food consumption. The combined weight of the dressing, the 1 liter of Hartman's solution, and any additional IV solutions were subtracted.

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Table 1 Operations performed

Operation	Mean time (range)	Number	Percentage
ASD	22.5 (10-44)	19	54
ASD/ACJ	35 (18-50)	6	17
Arthroscopic capsular release	27.6 (20-35)	7	20
Diagnostic arthroscopy	32 (31-33)	2	6
Rotator cuff repair	63	1	3
Total	27.4 (10-63)	35	100

Statistical methods

Pre- and postoperative data were analyzed using paired *t* tests and correlation between variables assessed using Pearson's correlation. A strong correlation was defined as an *R* value greater than .7. Statistical significant results were considered at $P < .05$.

RESULTS

Five patients did not have one of the parameters measured postoperatively and were excluded from the study. This left 35 patients with a mean age at surgery of 51.5 years (SD ± 13.6 , range, 19-83). Eighteen were male (51%), and 19 right shoulders (54%) were operated on. The majority of operations were performed by the consultant (57%), and the types of operations are presented in Table 1.

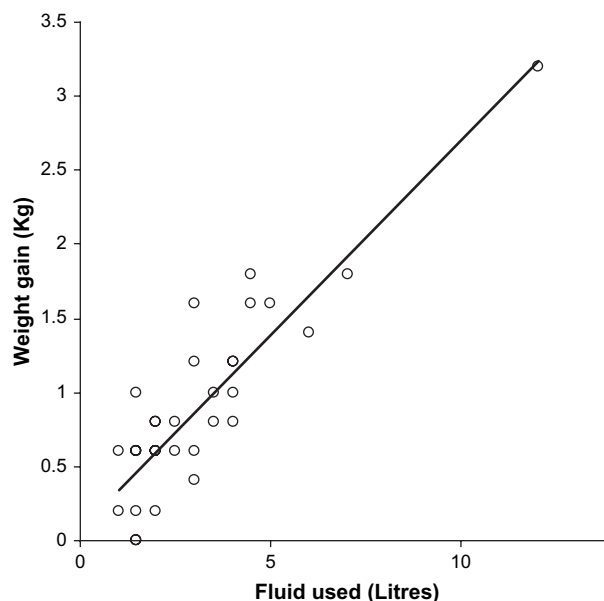
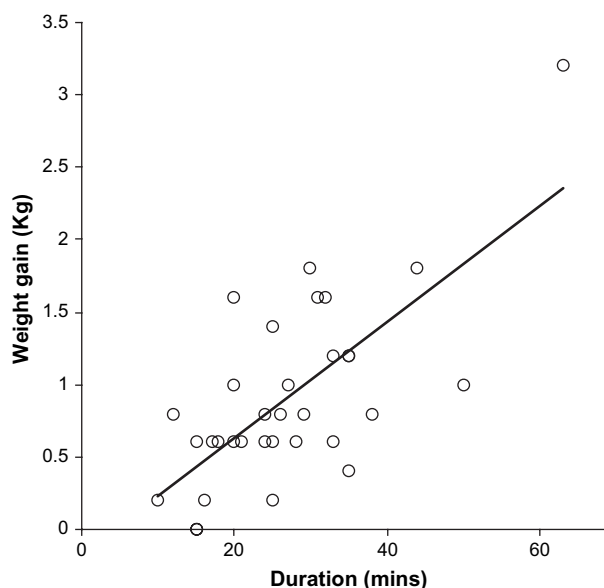
The mean time for surgery was 27.4 minutes (± 11.2 , 10-63) with a mean fluid use of 3.2 liters (± 2.2 , 1-12). There was a mean weight gain of 0.9 kg (0.64, 0-3.2, $P < .0001$), which related to a 1.2% (± 0.7 , 0-3.6%) weight gain. Both the hemoglobin and hematocrit decreased by 0.6 g/dl (± 0.5 , 0-2, $P < .0001$) and 1.5% (± 1.5 , 0-6%, $P < .0001$), respectively.

The time taken for the operation and the amount of fluid used correlated well ($R = .79$, $P < .0001$), as did the drop in hemoglobin and hematocrit ($R = .84$, $P < .0001$). There was a strong correlation between the amount of fluid used and the weight gain ($R = .89$, $P < .0001$) (Figure 1), as well as the duration of operation with weight gain ($R = .70$, $P < .0001$) (Figure 2).

However, no correlation was found between the amount of fluid used and the drop in hemoglobin or hematocrit, or change in pulse, blood pressure, or respiratory rate. No correlation was found for age or co-morbidities.

DISCUSSION

This study has demonstrated that patients undergoing routine shoulder arthroscopy do gain weight during the procedure, and that this is directly proportional to the amount of fluid used and duration of the operation. It can, therefore, be assumed that this is

**Figure 1** Correlation between fluid used and weight gain.**Figure 2** Correlation between duration of operation and weight gain.

due to the absorption of the irrigation fluid during the procedure. There was also an associated drop in hemoglobin and the hematocrit suggestive of a dilution effect.

Fluid accumulation around the shoulder is often seen after shoulder arthroscopy, but little is known about the effect of absorption of this fluid. One previous study showed a mean gain of 4.2 Lb (1.9 kg)⁴ during shoulder arthroscopy; however, in that

study, the mean operating time was 91.2 minutes, resulting in a mean of 30 liters of fluid being used. Our study correlates with these findings, but at much lower irrigation fluid usage and with a much stronger correlation between fluid gain and the length of operation and the amount of fluid used. This may suggest that, as the operation progresses, other factors, such as the physiologic age and co-morbidities of the patient, may play an increasing role in how the body deals with the fluid absorption. The reduction of the hematocrit by 1.5% is significantly lower than the 7.5% reported with rapid infusion of intravenous normal saline.⁵

Severe complications of excessive fluid accumulation, such as respiratory distress,¹⁻³ although rare, have been described in the literature; however, systemic effects from fluid retention have not been described. This study suggests that the fluid accumulated during the operation is slowly released back into the systemic circulation and does not produce a rapid change in the circulating volume. There may, however, be implications for elderly patients and prolonged arthroscopic surgery. Multiple procedures, such as rotator cuff repair with ACJ resection and biceps tenodesis, will increase the operating time and the amount of fluid used. This can correlate with more fluid absorption, which may not be tolerated well in the elderly patient.

In conclusion, routine shoulder arthroscopy does increase body weight by soft tissue fluid retention, but there is no significant effect on the circulating blood physiology. However, large amounts of fluid

can be absorbed with prolonged surgery and, very rarely, cause direct pressure effects. Therefore, shoulder arthroscopy should be performed in the least possible time, using the minimal amount of irrigation fluid necessary to visualize and complete the procedure safely.

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