International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

The Impact of Operating Time on Arthroscopic rotator cuff Surgeries

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Received: 20-05-2026
Accepted: 03-06-2026
Available online: 16-06-2026

ABSTRACT

Background: Arthroscopic shoulder surgery is a minimally invasive diagnostic and therapeutic procedure that relies on continuous fluid irrigation to distend the joint and maintain visibility [1]. However, prolonged exposure to irrigation fluid under pressure can lead to soft-tissue extravasation and systemic absorption, potentially causing local airway edema or systemic haemodilution [2,3].
Objectives: To evaluate the impact of operating time on post-operative local and systemic parameters by measuring perioperative shifts in anthropometric and haematological measurements.
Methodology: A prospective case study was conducted on 88 patients aged 20 to 70 years undergoing arthroscopic rotator cuff repair using a standard gravity irrigation system. Anthropometric parameters (neck, chest, and mid-arm circumferences, weight) and haematological markers (Haemoglobin [Hb], Packed Cell Volume [PCV], Serum Sodium [Na+]) were measured pre-operatively and 1-hour post-operatively. The cohort was stratified by surgical duration (<60min vs >60min) to evaluate time-dependent variations using paired t-tests.
Results: The study included 88 subjects (76 males, 12 females) with an average age of 44 years. Post-operatively, the entire cohort demonstrated significant mean increases in body weight ($p < 0.001$), neck circumference ($p < 0.001$), mid-arm circumference ($p < 0.001$), and serum sodium ($p < 0.001$), alongside significant declines in Haemoglobin ($p < 0.001$) and PCV ($p < 0.001$). No significant change occurred in chest circumference ($p = 0.735$). When stratified by duration, operating times exceeding 60minutes resulted in a significantly greater drop in PCV ($p = 0.034$) compared to shorter procedures. No clinical airway compromise was observed.
Conclusion: Surgical duration drives measurable changes in local tissue edema and dilutional haematological transitions during shoulder arthroscopy. While these changes did not cause clinical respiratory distress in this cohort, we suggest keeping operating time under 60 minutes as a prudent strategy to limit systemic fluid retention and balance alterations.

Keywords: Shoulder Arthroscopy, Rotator cuff repair Operating Time, Gravity Irrigation, Extravasation, Haemodilution.

INTRODUCTION

Arthroscopic shoulder surgery is widely utilized for managing rotator cuff tears and various glenohumeral pathologies[4]. To maintain adequate visual clarity and joint distension during these procedures, large quantities of fluid are continuously infused into the joint workspace under hydrostatic pressure[5].

Because the subacromial and glenohumeral spaces lack rigid fascial containment, fluid can easily extravasate into the surrounding soft tissues of the neck, chest, and upper extremity[6,7]. Prolonged surgical procedures involving subacromial

space as in rotator cuff repair surgeries compound this risk, increasing both local tissue fluid tracking and direct intravascular fluid absorption.

Extensive fluid extravasation can lead to localized complications, such as airway edema or tracheal compression, while systemic absorption can cause haemodilution and electrolyte shifts.

While automated infusion pumps are common in some settings, many public healthcare institutions rely on gravity-fed systems for intra-articular irrigation[8,9]. This study evaluates how operating time affects systemic fluid shifts and anthropometric measurements using a gravity-fed setup, helping to identify time-based safety thresholds for clinical practice.

MATERIALS AND METHODS

2.1 Study Design and Selection

This prospective case study was conducted in the Department of Orthopaedics at Government Medical College, Thiruvananthapuram, among 88 patients undergoing arthroscopic rotator cuff repair.

- **Inclusion Criteria:** Patients aged 20 to 70 years.
- **Exclusion Criteria:** Patients who did not provide written informed consent.

2.2 Surgical and Irrigation Protocol

All procedures were performed in the lateral decubitus position with upper limb traction[10]. Joint irrigation was managed via a gravity system, suspending 3L bags of standard Normal Saline (0.9 NaCl) at a fixed height of 3meters above the floor to provide reliable hydrostatic pressure[11].

2.3 Variables and Measurements

Baseline clinical parameters were recorded on the morning of surgery and repeated 1 hour post-operatively:

1. **Anthropometric Measures:** Weight, neck circumference, mid-arm circumference (MAC), and chest circumference.
2. **Laboratory Measures:** Total Haemoglobin (Hb), Packed Cell Volume (PCV), and Serum Sodium (Na^+).

Total operating time (minutes from primary incision to final closure) was precisely recorded for each case.

2.4 Statistical Arm Stratification

To evaluate the specific impact of surgical duration, the study population (N=88) was divided into two analytical groups based on operative time:

- **Shorter Duration Group:** Operating time <60minutes (n = 38). -
- **Prolonged Duration Group:** Operating time >60minutesn = 47).

Note: Missing operative logs for 3 patients restricted them to the global cohort analysis, leaving 85 patients available for direct time-stratified subgroups.

Pre- and post-operative variations were analyzed using paired t-tests via SPSS software, with statistical significance set at $p < 0.05$.

RESULTS

3.1 Baseline Metrics

The study cohort consisted of 88 patients: 76 males (86.4%) and 12 females (13.6%), with a mean age of 44 years.

3.2 Global Pre- versus Post-Operative Changes

Analysis of the entire cohort showed significant post-operative shifts across almost all anthropometric and haematological markers (Table 1).

Table 1: Overall Cohort Perioperative Variations (N=88)

Metric Evaluated	Pre-Operative Mean (±SD)	Post-Operative Mean (±SD)	Mean Shift (±SD)	t-value	p-value	Clinical Signif.
Weight (kg)	66.07 +/- 11.12	67.19 +/- 10.29	+1.12 +/- 0.90	11.635	<0.001	Highly Sig.
Neck Circ. (cm)	35.91+/- 7.02	37.14+/- 6.82	+1.23 +/- 0.93	12.413	<0.001	Highly Sig.

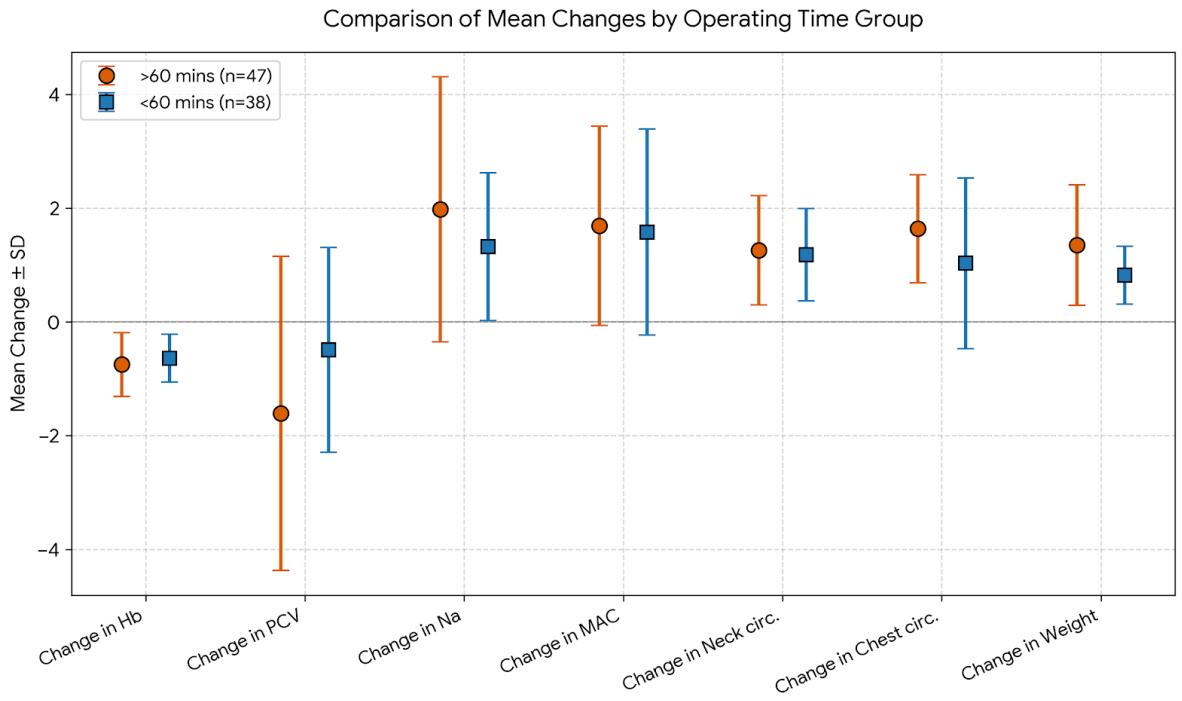
Metric Evaluated	Pre-Operative Mean (±SD)	Post-Operative Mean (±SD)	Mean Shift (±SD)	t-value	p-value	Clinical Signif.
Mid-Arm Circ. (cm)	30.52+/- 12.13	32.16+/- 12.21	+1.64 +/- 1.79	8.568	<0.001	Highly Sig.
Chest Circ. (cm)	81.47+/- 15.05	81.18+/- 15.12	+0.29 +/- 7.85	-0.339	0.735	Not Sig.
Hemoglobin (g/dL)	13.66+/- 1.28	12.73+/- 2.06	-0.94 +/- 1.53	5.764	<0.001	Highly Sig.
PCV (%)	39.06 +/- 3.30	37.51+/- 3.37	-1.54 +/- 2.76	4.432	<0.001	Highly Sig.
Serum Sodium (mEq/L)	136.25 +/- 2.63	137.94+/- 2.36	+1.69 +/- 1.97	8.056	<0.001	Highly Sig.

3.3 Comparative Changes Based on Surgical Time

Stratifying the data by surgical duration revealed that procedures extending past 60 minutes resulted in a significantly larger drop in Packed Cell Volume ($p = 0.034$), and also significant increase in chest circumference($p = 0.029$) and weight($p = 0.006$) of the subjects compared to procedures completed within 60 minutes. Changes in hemoglobin, sodium levels, and local circumferences were higher in the prolonged group but did not reach standalone statistical significance between the two subgroups (Table 2).

Table 2: Comparative Metric Alterations by Operating Time Grouping

Parameter (Mean Change ±SD)	Duration <60 min (n=38)	Duration >60 min (n=47)	t-value	p-value	Statistical Significance
Change in PCV	-0.49+/-1.85	-1.61 \pm 2.76	-2.154	0.034	**Significant** ($p < 0.05$)
Change in Hemoglobin	-0.64 +/-0.44	-0.75+/-0.56	-0.951	0.344	Not Significant
Change in Serum Sodium	+1.32+/-1.38	+1.98+/-2.33	1.560	0.123	Not Significant
Change in Mid-Arm Circ.	+1.58+/-1.88	+1.69+/-1.75	0.278	0.782	Not Significant
Change in Neck Circ.	+1.18+/-0.91	+1.26+/- 0.96	0.390	0.697	Not Significant
Change in Chest circumference	+1.03+/-1.5	+1.64+/- 0.95	2.223	0.029	**Significant** ($p < 0.05$)
Change in Weight	+0.82 +/- 0.51	+1.35+/- 1.06	2.84	0.006	**Significant** ($p < 0.05$)



DISCUSSION

The statistical results confirm that surgical duration plays a measurable role in fluid retention and distribution during shoulder arthroscopy. Across the entire cohort, significant increases in weight (+1.12kg), mid-arm circumference (+1.64cm), and neck circumference (+1.23cm) demonstrate that irrigation fluid regularly transitions into adjacent soft tissue spaces during these procedures.

The systemic drops in post-operative haemoglobin (-0.94g/dL) and PCV (-1.54%) are consistent with intravascular haemodilution from fluid absorption rather than active blood loss. Recognizing this dilutional effect is clinically valuable, as it helps avoid unnecessary post-operative blood transfusions in asymptomatic patients.

Our time-stratified analysis shows that procedures lasting longer than 60 minutes result in a significantly larger drop in PCV (-1.61% vs -0.49%, p=0.034). This difference confirms that longer surgical times allow for continuous fluid absorption, increasing systemic haemodilution.

Operative Time >60 Mins ⟶ Prolonged Hydrostatic Pressure ⟶ Increased Fluid Absorption ⟶ Significant PCV Decline (p=0.034)

Significant increase was noted in chest circumference (p = 0.029) and weight (p = 0.006) of the subjects in procedures which took longer than 60 minutes. To mitigate the significant gains in patient weight and chest circumference, along with drop in PCV observed in surgeries exceeding 60 minutes, surgical teams must prioritize streamlined planning and staff coordination to reduce duration.

We also noted a consistent rise in post-operative serum sodium levels across the cohort (+1.69 mEq/L: p<0.001). This trend is directly linked to the systemic absorption of normal saline (0.9%NaCl), which has a higher sodium concentration (154mEq/L) than baseline physiological serum ranges.

Importantly, although neck measurements increased across the cohort, these local changes did not cause clinical airway obstruction, tracheal displacement, or respiratory issues in any patients. These findings indicate that while gravity-fed irrigation arrays remain safe, minimizing surgical times to under 60 minutes helps limit tissue edema and systemic fluid retention. This can be supported by careful pre-operative planning and efficient surgical team coordination.

CONCLUSION

Prolonged operating times during arthroscopic shoulder surgery significantly contribute to regional fluid extravasation and systemic haemodilution. Using a standard gravity irrigation system keeps fluid entry within safe limits, avoiding severe clinical airway issues. However, procedures that extend past 60 minutes cause a significantly greater decline in patient haematocrit values and increase in chest circumference and weight of subjects. To improve patient safety and minimize

fluid-related shifts, surgical teams should optimize operative efficiency and minimize surgical duration through structured procedural planning.

Recommendations

This study evaluated fluid shifts exclusively using manual gravity irrigation at a static height within a single centre. We recommend a multicentric study to compare these time-dependent changes between gravity setups and automated pressure-pump irrigation systems.

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