



Original Article

Regional and systemic effects of Irrigation Fluid in shoulder arthroscopy

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ABSTRACT

Background and Aim: Visualizing unencapsulated subacromial spaces during shoulder arthroscopy requires fluid irrigation under pressure, risking soft-tissue extravasation[1,2]and systemic absorption[3] that can compromise the upper airway[4]. This prospective longitudinal study evaluates variations in post-operative anthropometric profiles and haematological parameters to assess subclinical extravasation risks relative to irrigation volumes.

Methods: Eighty-eight adults (aged 15–70 years) undergoing arthroscopic rotator cuff repair using a gravity irrigation system were monitored. Pre- and post-operative haematological parameters - Haemoglobin[Hb], packed cell volume [PCV], serum sodium [Na⁺] and anthropometric dimensions -mid-arm circumference [MAC], neck circumference, chest circumference, weight) were recorded alongside fluid utilization volumes.

Results: Significant post-operative dilutional drops occurred in mean Hb (13.66 to 12.73g/dl $p < 0.001$) and PCV (39.06% to 37.51% $p < 0.001$). Serum sodium increased marginally from 136.25 to 137.94mEq/L $p < 0.001$). Anthropometric changes revealed significant regional fluid retention: mean weight rose by 1.12kg $p < 0.001$, MAC by 1.64 cm $p < 0.001$, and neck circumference by 1.23 cm $p < 0.001$. Changes in chest circumference were non-significant ($p = 0.735$). All deviations correlated positively with increased irrigation fluid volume and operating time.

Conclusion: Irrigation fluid volume exerts significant systemic and regional tissue impact. While subclinical extravasation was highly prevalent, it did not culminate in macro-airway or respiratory compromise. Efficient surgical execution and disciplined fluid management remain essential protective strategies.

Keywords: Shoulder Arthroscopy; Fluid Extravasation; Dilutional Anaemia; Neck Circumference; Airway Obstruction; Rotator Cuff Repair.

INTRODUCTION

Shoulder arthroscopy has expanded drastically to become the standard of care for addressing intra-articular and extra-articular pathology, shifting the management of large rotator cuff tears away from morbid open techniques to high-precision, minimally invasive interventions. The clinical benefits include dramatically less post-operative pain, compressed hospital stays, and early functional rehabilitation timelines.

However, maximizing visualization within the narrow glenohumeral joint and the unencapsulated subacromial space demands continuous hydrostatic joint distension using massive fluid volumes[5]. Unlike the encapsulated glenohumeral joint capsule, which accepts limited expansion, the subacromial zone directly borders loose fascial tissue pathways flowing

freely into the neck and chest wall compartments. Pressurized fluid delivery within this zone can provoke rapid localized extra-articular soft-tissue extravasation and concurrent absorption into systemic blood circulation.

Extensive localized fluid dissection carries rare but potentially catastrophic complications, including massive facial-cervical edema, acute laryngeal swelling, and severe external upper-airway compression leading to life-threatening respiratory obstruction [6]. Literature highlights numerous scenarios where critical airway swelling required urgent re-intubation or ICU ventilation support[7]. Despite these documented risks, there remains a distinct scarcity of prospective clinical trials quantifying how common anthropometric metrics shift alongside precise systemic blood changes to pre-emptively signal fluid management strain.

This study seeks to bridge these gaps by determining the direct association of normal saline irrigation volume and overall operating duration with objective immediate post-operative alterations across patients' systemic haematological panels and physical regional body circumferences.

METHODOLOGY

Study Design and Setting: This prospective longitudinal study was conducted across a one-year timeframe within the orthopaedic wards of Government Medical College, Thiruvananthapuram, India, following formal institutional human ethics committee clearance and the acquisition of informed written patient consent.

Study Population: The study sample size calculated an enrolment of 85 individuals based on pre-established power configurations using variance within post-operative chest dimensions. Eighty-eight sequential adult patients presenting for elective arthroscopic rotator cuff repair were successfully monitored. Patients refusing to provide written informed consent were excluded.

Surgical Protocol: All procedures were performed under standard anaesthesia profiles utilizing a standard gravity-driven irrigation setup to ensure uniform delivery of traditional room-temperature isotonic (0.9%) normal saline fluid. Total volumetric consumption of fluid (in litres) was meticulously recorded upon skin closure.

Data Gathering and Variables: Identical baseline evaluations were performed immediately pre-operatively and within the immediate post-operative window.

- *Hematological Markers:* Venous blood draws quantified Haemoglobin (Hb, g/dL), Packed Cell Volume (PCV, %), and Serum Sodium (Na⁺, mEq/L).
- *Anthropometric Profile:* Standardized clinical measuring techniques were applied to record Mid-Arm Circumference (MAC, cm), Neck Circumference (cm), Chest Circumference (cm), and overall Body Weight (kg).

Statistical Analysis: Gathered quantitative datasets were exported to analytical software platforms. Continuous variables were verified and summarized as mean± standard deviation (SD). Pre- and post-operative variations were formally evaluated utilizing paired t-tests, with statistical significance established at a threshold of $p < 0.001$. Scatter plots and linear regression analyses mapped trends against fluid volume and operating times.

RESULTS

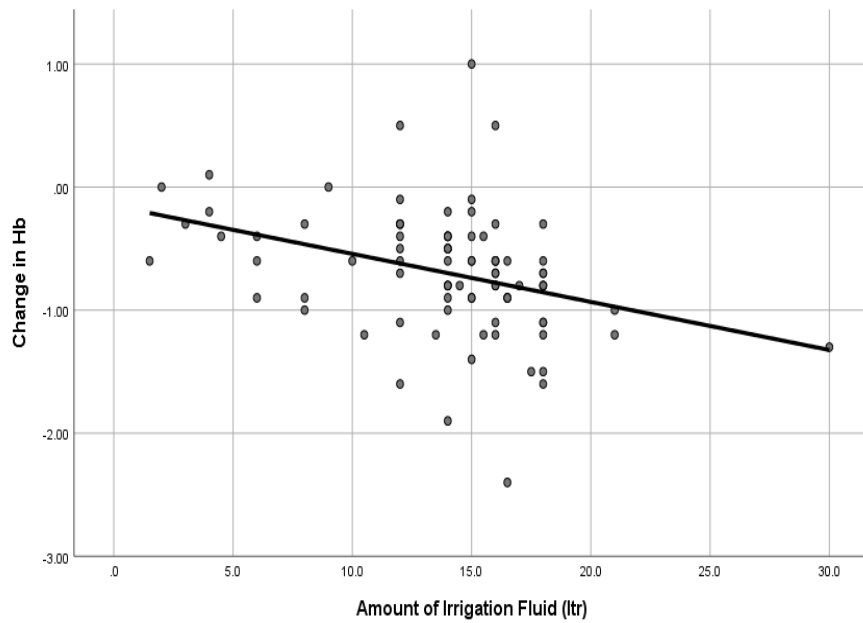
The investigated cohort comprised 88 subjects. Demographic analysis showed a predominant male distribution (77%) over female (23%), with the primary age cluster localized between 20 and 60 years of age.

Haematological Parameter Variations

A uniform, statistically significant decline in oxygen-carrying blood constants occurred post-operatively. Mean Haemoglobin dipped by 0.94 g/dL ($p < 0.001$). Correspondingly, Packed Cell Volume experienced a parallel systemic reduction of 1.54% ($p < 0.001$). Conversely, serum sodium concentrations experienced a significant upward shift, elevating by a mean value of 1.69mEq/L ($p < 0.001$).

Change in hemoglobin

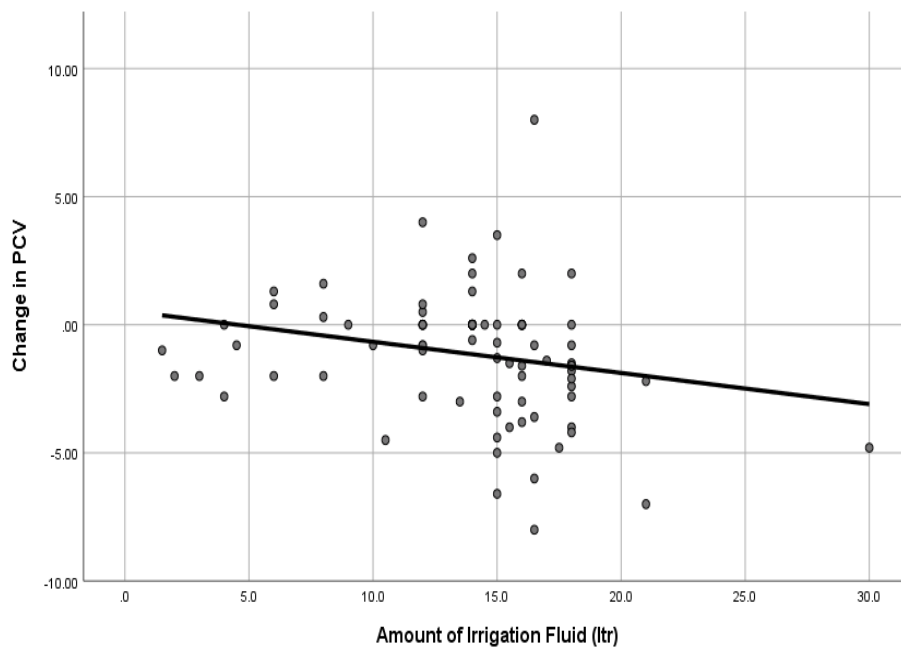
	N	Hb		Paired Differences		Paired t test	
		Mean	sd	Mean	sd	t	p
Pre	88	13.66	1.28	0.94	1.53	5.764	<0.001
Post	88	12.73	2.06				



Hemoglobin levels decreased significantly with increase in amount of irrigation fluid used

Change in pcv

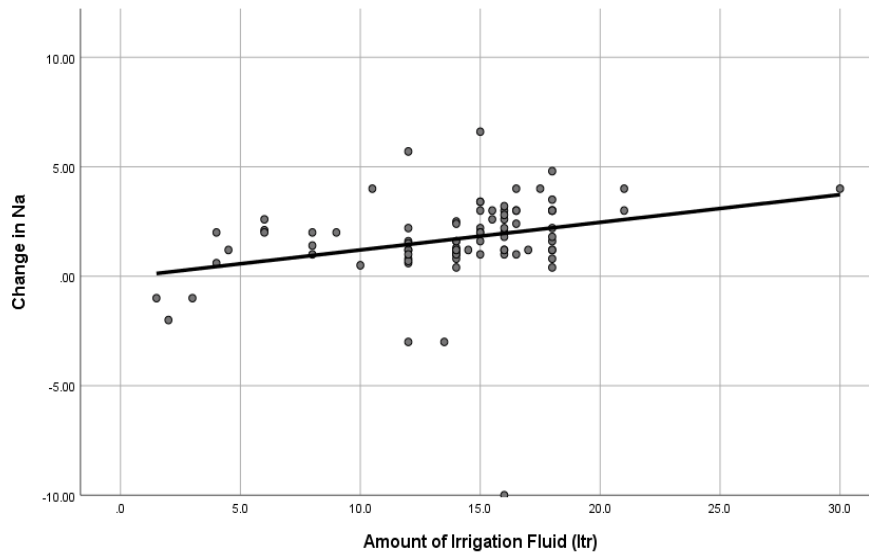
	N	PCV		Paired Differences		Paired t test	
		Mean	sd	Mean	sd	t	P
Pre	88	39.06	3.30	1.54	2.76	4.432	<0.001
Post	88	37.51	3.37				



PCV decreased significantly with increase in amount of irrigation fluid used.

Change in serum sodium

	N	Sodium		Paired Differences		Paired t test	
		Mean	sd	Mean	sd	t	P
Pre	88	136.25	2.63	1.69	1.97	8.056	<0.001
Post	88	137.94	2.36				



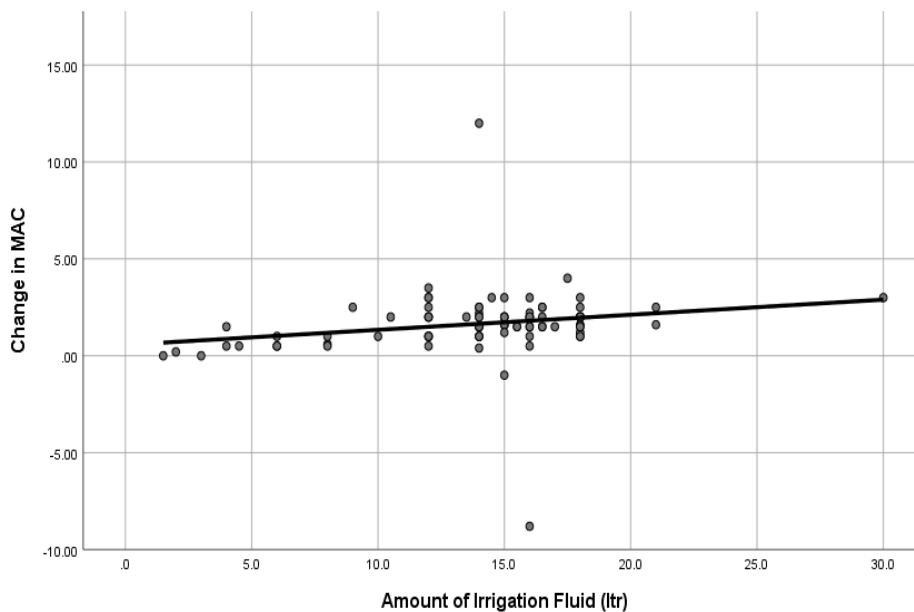
S.sodium increased significantly with increase in amount of irrigation fluid used and operating time.

Anthropometric Changes

Physical structural tracking demonstrated substantial localized swelling and systemic water preservation across multiple anatomical sites:

Change in mid arm circumference

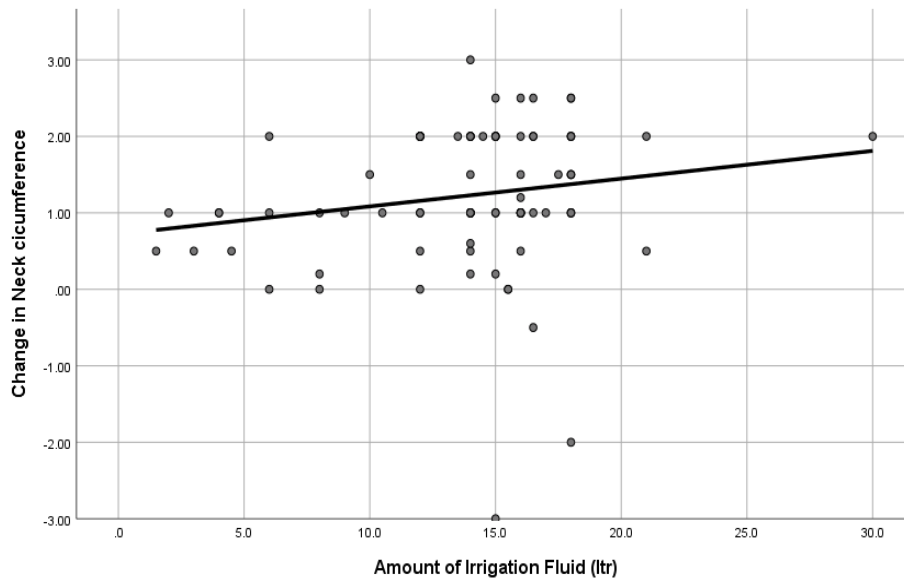
	N	MAC		Paired Differences		Paired t test	
		Mean	Sd	Mean	sd	t	P
Pre	88	30.52	12.13	1.64	1.79	8.568	<0.001
Post	88	32.16	12.21				



Mid Arm Circumference increased significantly with increase in amount of irrigation fluid used.

Change in neck circumference

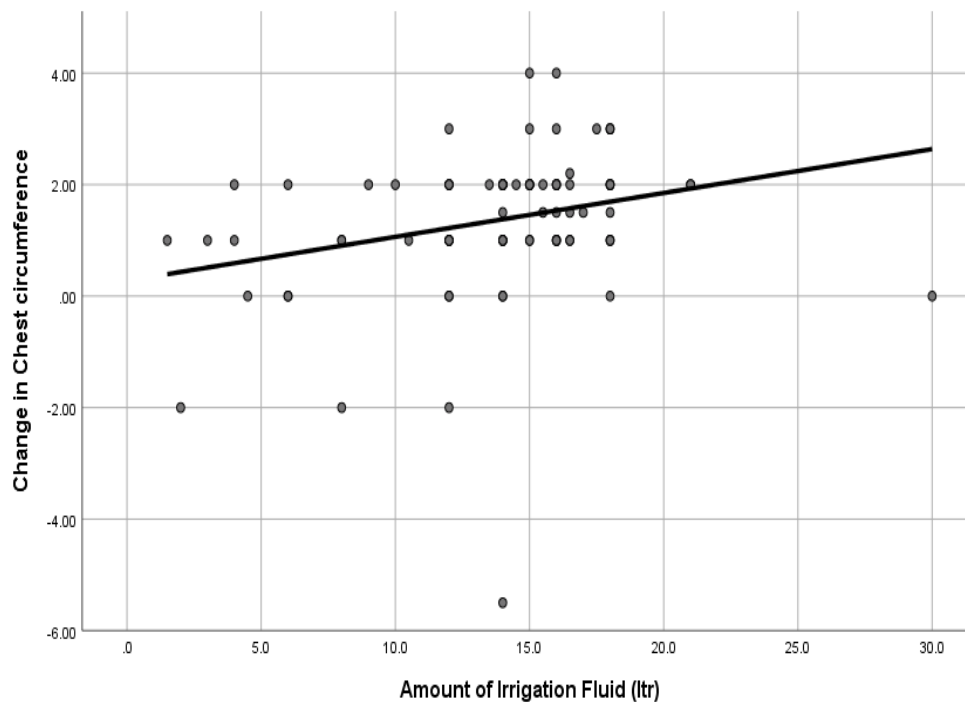
	N	Neck		Paired Differences		Paired t test	
		Mean	sd	Mean	sd	t	P
Pre	88	35.91	7.02	1.23	0.93	12.413	<0.001
Post	88	37.14	6.82				



Neck Circumference increased significantly with increase in amount of irrigation fluid used.

Change in chest circumference

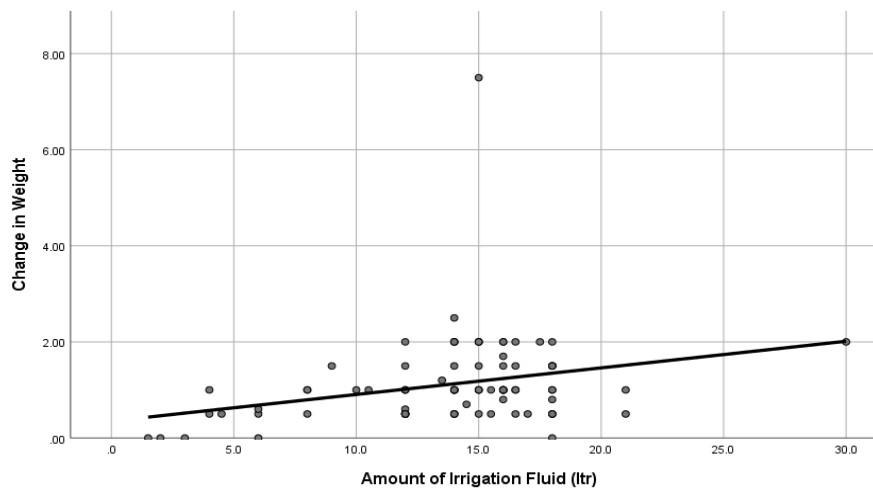
	N	Chest circumference in cm		Paired Differences		Paired t test	
		Mean	Sd	Mean	sd	t	P
Pre	88	81.47	15.05	-0.29	7.85	-0.339	0.735
Post	88	81.76	17.62				



Chest Circumference increased significantly with increase in amount of irrigation fluid used.

Change in weight

	N	Weight in Kg		Paired Differences		Paired t test	
		Mean	Sd	Mean	Sd	t	P
Pre	88	66.07	10.40	1.12	0.90	11.635	<0.001
Post	88	67.19	10.29				



Weight of the patient increased significantly with increase in amount of irrigation fluid used.

Regression and scatter-plot tracking demonstrated a direct linear relationship: patients exposed to prolonged surgical periods or larger volumes of irrigation fluid displayed more extreme changes in Hb dilution, sodium accumulation, and regional tissue expansion. The maximum recorded physical expansions in individual outliers reached up to 4 cm for both neck and mid-arm circumferences, and 5 cm for chest width.

DISCUSSION

Pressurized fluid irrigation provides essential joint distension and clear visualization in arthroscopy [8]. However, this study demonstrates that fluid extravasation into neighbouring unencapsulated soft tissues is a regular clinical occurrence rather than an isolated anomaly. The significant, uniform post-operative increases in patients' neck and mid-arm circumferences provide clear physical evidence of localized interstitial fluid retention.

Our findings reveal a significant mean post-operative weight gain of 1.12kg that correlates directly with irrigation volume. While young, healthy cohorts easily tolerate this subclinical fluid retention, it presents a serious clinical challenge for elderly populations or patients with compromised cardiorespiratory or renal functions, where sudden fluid accumulation can precipitate systemic volume overload [9,10].

Systemically, the significant drops in post-operative Haemoglobin {0.94g/dL} and PCV (1.54%) reflect intravascular haemodilution from systemic fluid absorption. Recognizing this dilutional aetiology is crucial for post-operative management, as it prevents unnecessary and potentially harmful blood transfusions. Furthermore, the concurrent increase in serum sodium (1.69mEq/L) underscores the systemic absorption of normal saline (0.9% NaCl). This finding supports the strict use of normal saline over non-isotonic alternatives to avoid severe acid-base or electrolyte crises[11,12].

Importantly, though soft-tissue extravasation was highly prevalent across our cohort, it did not lead to macro-clinical airway obstruction or respiratory failure in any patient. This confirms that while subclinical fluid migration is common, serious upper-airway compromise remains an uncommon risk. To minimize these risks, surgical teams should target modifiable procedural risk factors—specifically by optimizing operating times and minimizing irrigation fluid volumes through precise surgical planning and well-trained assistant support. Utilizing simple, non-invasive measurements like neck circumferences and standard lab panels can provide reliable, early warnings of fluid extravasation before clinical complications arise.

CONCLUSION

Shoulder arthroscopy utilizing routine pressurized saline induces significant subclinical localized tissue extravasation and systemic haemodilution. These changes correlate directly with prolonged operating times and high-volume fluid irrigation. While these fluid shifts did not cause clinical airway compromise in our study, they can be minimized through concise operative timelines, meticulous fluid monitoring, and precise surgical planning.

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