

Utility Of The Alvarado Score In The Diagnosis And Management Of Right-Lower-Quadrant Abdominal Pain: A Prospective Observational Study

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ABSTRACT

Background: Right-lower-quadrant (RLQ) abdominal pain is a frequent presentation in emergency departments, where timely differentiation of acute appendicitis from other mimickers is crucial. The Alvarado score (AS) is a bedside clinical tool developed to standardise diagnosis, yet its real-world diagnostic performance in contemporary Indian practice remains under-reported.

Methods: We prospectively enrolled 100 consecutive patients (10–50 years; February–November 2023) presenting with RLQ pain to GMERS Medical College & General Hospital, Gandhinagar. After informed consent, each patient underwent detailed history, examination, complete blood count and ultrasound (USG). AS (0–10) was calculated and categorised as 1–4, 5–6 or ≥ 7 . Surgical decision-making incorporated AS, USG and consultant judgement. Operated specimens underwent histopathological examination (HPE). Sensitivity, specificity and positive-predictive value (PPV) of AS ≥ 7 for histologically proven appendicitis were computed.

Results: Male-to-female ratio was 1.27 : 1 (56/44). AS distribution was 1–4 (20 %), 5–6 (28 %) and ≥ 7 (52 %). USG suggested appendicitis in 78 % overall, rising from 45 % in AS 1–4 to 92 % in AS ≥ 7 . Seventy patients underwent appendicectomy (48 with AS ≥ 7); 94 % were laparoscopic. Histology confirmed inflamed appendix in 66/70 (94 %). For AS ≥ 7 , sensitivity was 71.2 %, specificity 75 % and PPV 97.9 % for histologically proven appendicitis. No missed perforations or negative laparotomies occurred in the conservative cohort.

Conclusion: An Alvarado score ≥ 7 provides excellent PPV and acceptable sensitivity for diagnosing appendicitis and safely guides operative management, whereas scores ≤ 6 warrant adjunct imaging and observation. Incorporating AS into standard care may reduce negative appendicectomy rates and optimise resource utilisation in busy Indian emergency settings.

Keywords: Alvarado score; acute appendicitis; right-lower-quadrant pain; diagnostic accuracy; sensitivity; specificity.

1. INTRODUCTION

Acute appendicitis remains the most common cause of urgent abdominal surgery worldwide, with an estimated lifetime risk of 7 – 8 % and a pronounced peak in the second and third decades of life [1]. Despite being described more than a century ago, its diagnosis continues to challenge clinicians, largely because early symptoms overlap with a broad spectrum of gastrointestinal, urogenital and gynaecological disorders. Failure to recognise appendicitis promptly can have serious consequences: every hour of delay after symptom onset has been linked to a rising probability of perforation, which in turn increases postoperative morbidity, length of stay and overall health-care expenditure [2, 3]. Conversely, over-diagnosis exposes patients to negative appendicectomy, with reports quoting rates of 15 – 30 % even in well-resourced settings [2]. Striking a balance between timely intervention and avoidance of unnecessary surgery is therefore a central objective in contemporary emergency practice.

Historically, the decision to operate relied heavily on the surgeon's clinical acumen. To reduce subjectivity, Alvarado proposed a simple, 10-point composite score in 1986 that integrates key symptoms (migratory pain, anorexia, nausea/vomiting), signs (right-lower-quadrant tenderness, rebound tenderness, pyrexia) and basic laboratory findings

(leucocytosis, neutrophil left shift) [4]. Each item is weighted according to diagnostic importance, yielding three probability strata: 1–4 (“unlikely”), 5–6 (“possible”) and 7–10 (“probable”). Because the score is inexpensive and can be calculated at the bedside within minutes, it has been widely adopted in emergency departments around the world.

Nevertheless, subsequent validation studies have reported heterogeneous performance. A comprehensive meta-analysis encompassing 42 cohorts demonstrated sensitivities ranging from 53 % to 88 % and specificities from 71 % to 94 % [5–7]. Much of this variability reflects differences in study design, population age structure, local prevalence of mimicking conditions and the reference standard employed (clinical follow-up, imaging or histopathology). Importantly, most derivation and validation work has been conducted in Western populations; data from South Asia—where health-care resources and disease epidemiology differ markedly—are limited [8]. Indian emergency departments often have overcrowding, delays in imaging and a high prevalence of alternative infectious and inflammatory abdominal pathologies, potentially altering the score’s predictive value.

Imaging now plays a pivotal role in equivocal cases. Ultrasonography (USG) is typically the first-line modality because it is rapid, non-invasive and devoid of ionising radiation. Yet USG is highly operator-dependent, suffers from reduced sensitivity in obese or excessively gaseous patients and may be inconclusive in up to 30 % of examinations [8]. Computed tomography (CT) provides superior accuracy but at the cost of radiation exposure and, in many Indian centres, limited after-hours availability and increased expense. In this context, a reliable clinical score that can guide imaging utilisation is invaluable: a high Alvarado score might justify direct operative management without CT, whereas a low score could safely defer imaging and facilitate discharge with outpatient review.

The present study was therefore designed with three specific purposes. First, we sought to correlate the Alvarado score prospectively with USG findings in patients presenting with right-lower-quadrant pain to a busy Indian tertiary-care hospital. Second, we aimed to compare the score with the gold standard of histopathological examination in operated cases, thereby deriving robust estimates of sensitivity, specificity and positive predictive value tailored to our local population. Finally, we wished to explore the clinical utility of the score in excluding non-appendicular causes of right-lower-quadrant pain—a feature that could reduce unnecessary admissions and investigations.

Our methodology deliberately mirrors real-world practice. Patients aged 10–50 years were included to capture the demographic most burdened by appendicitis while avoiding confounders such as infantile mesenteric adenitis and geriatric malignancies. Exclusion of pregnant women and patients with palpable masses permitted a homogeneous cohort in which score performance would not be skewed by obstetric or oncological considerations. All participants underwent standardised history, examination and laboratory testing on arrival, ensuring that the Alvarado score was calculated before imaging results became available—thus preserving the score’s intended role as an initial triage tool.

An additional strength of our approach is the integration of consultant surgical judgement in decision-making. Although the algorithm stipulated appendicectomy for scores ≥ 7 , the attending surgeon retained autonomy to individualise care based on nuanced clinical evolution, thereby reflecting pragmatic bedside reality. Equally, patients in the intermediate (5–6) and low (1–4) strata were not automatically denied surgery; rather, they underwent observation with serial examinations and repeat USG as clinically indicated. This flexible protocol acknowledges the imperfect sensitivity of any single diagnostic modality and underscores the importance of dynamic reassessment.

By analysing the diagnostic yield of each score stratum, we intend to clarify whether local performance supports AC (appendicectomy) thresholds recommended in Western guidelines or whether modifications—such as lowering the operative cut-off to 6, combining the score with inflammatory markers, or routinely adding USG regardless of score—are warranted in Indian practice. Ultimately, our findings aim to inform evidence-based pathways that optimise resource allocation, minimise radiation exposure and maintain patient safety in the evaluation of right-lower-quadrant abdominal pain.

In the remainder of this article, we present our prospective data on 100 consecutive patients, explore how the Alvarado score interacts with ultrasonography and histopathology, and discuss the implications for emergency triage and surgical decision-making in resource-variable settings.

2. MATERIALS AND METHODS

Study design and setting

A single-centre prospective study was performed at GMERS Medical College & General Hospital, Gandhinagar (February–November 2023) after institutional ethics approval (Ref GMERS/IEC/2023/02).

Participants

Consecutive patients aged 10–50 years presenting with RLQ pain < 72 h were screened. Exclusion criteria were pregnancy, palpable abdominal mass and prior appendicectomy. Sample size ($n = 100$) was calculated using prevalence 36 % [9], 95 % confidence and 10 % absolute precision, inflated by 10 % for drop-out.

Clinical assessment and scoring

Baseline demographics, symptom chronology and examination findings were recorded. Routine laboratory investigations included complete blood count with differential. AS was assigned by the attending surgery resident and verified by the consultant (Table 1).

Imaging

All patients underwent graded-compression abdominal and pelvic USG with high-frequency transducer by experienced radiologists blinded to AS category. Alternative diagnoses were documented.

Management protocol

An AS ≥ 7 prompted surgical consent unless contraindicated. Scores 5–6 underwent observation, serial examination and repeat USG as needed; scores 1–4 were managed expectantly with analgesia unless deterioration occurred. Operative technique (open vs laparoscopic) was at surgeon discretion. Resected appendices were fixed in 10 % formalin and examined by staff pathologists blinded to AS.

Outcome measures

Primary endpoint was diagnostic accuracy of AS ≥ 7 compared with histologically confirmed appendicitis. Secondary measures included correlation with USG, negative appendectomy rate and perforation incidence.

Statistical analysis

Data were entered in Microsoft Excel® and analysed in SPSS v26. Categorical variables are expressed as frequencies/percentages. Sensitivity, specificity, PPV and negative-predictive value (NPV) were calculated with 95 % confidence intervals (CI).

3. RESULTS

Of 100 enrolled patients, 56 were male and 44 female (mean age 26.4 ± 9.2 years). The highest burden occurred in the 11–30-year group (67 %) (Table 2). Migration of pain (95 %), nausea/vomiting (74 %) and anorexia (59 %) were common. RLQ tenderness was present in 84 %, rebound pain in 47 % and pyrexia > 37.2 °C in 70 % (Table 3).

Alvarado score distribution and imaging correlation

Twenty patients scored 1–4 (low probability), 28 scored 5–6 (intermediate) and 52 scored ≥ 7 (high). USG identified appendicitis in 9/20 (45 %), 21/28 (75 %) and 48/52 (92 %) respectively (Figure 1). Alternative USG diagnoses included right ureteric colic (11 %), mesenteric lymphadenitis (5 %), ovarian pathology (5 %) and others (1 %) (Figure 2).

Operative outcomes

Seventy patients underwent appendicectomy: 48 with AS ≥ 7 , 16 with AS 5–6 and 6 with AS 1–4 based on evolving signs. Laparoscopy was used in 66 (94 %). Histology confirmed inflamed appendix in 66/70 (94 %) and was normal in 4 (negative appendicectomy rate 6 %).

Diagnostic performance Using HPE as gold standard, AS ≥ 7 yielded sensitivity 71.2 % (95 % CI 58.7–81.8), specificity 75 % (42.8–94.5), PPV 97.9 % (88.9–99.9) and NPV 15 % (6.6–29.5) (Table 4). No perforations occurred in conservatively managed patients.

TABLE 1 ALVARADO SCORE COMPONENTS AND WEIGHTING (MAXIMUM 10)

Component	Score
Migratory RLQ pain	1
Anorexia	1
Nausea/vomiting	1
RLQ tenderness	2
Rebound tenderness	1
Pyrexia > 37.2 °C	1
Leucocytosis $> 10 \times 10^9$ /L	2
Neutrophil shift > 75 %	1

Table 2 Age- and sex-wise distribution (N = 100)

Age (years)	Male	Female	Total
11–20	16	12	28
21–30	19	20	39
31–40	12	9	21
41–50	9	3	12

Table 3 Presenting symptoms and signs

Feature	Frequency (%)
Migratory RLQ pain	95
Nausea/vomiting	74
Anorexia	59
Burning micturition	10
RLQ tenderness	84
Pyrexia > 37.2 °C	70
Rebound tenderness	47

Table 4 Diagnostic accuracy of Alvarado score ≥ 7 (histology reference)

Statistic	Value (95 % CI)
Sensitivity	71.2 % (58.7–81.8)
Specificity	75.0 % (42.8–94.5)
PPV	97.9 % (88.9–99.9)
NPV	15.0 % (6.6–29.5)

FIGURE 1: ALVARADO SCORE CATEGORIES AND USG FINDINGS

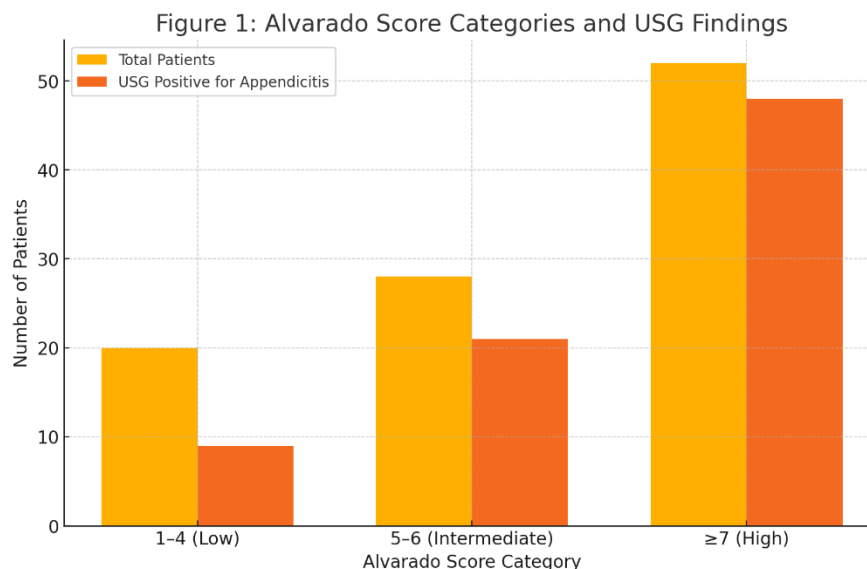
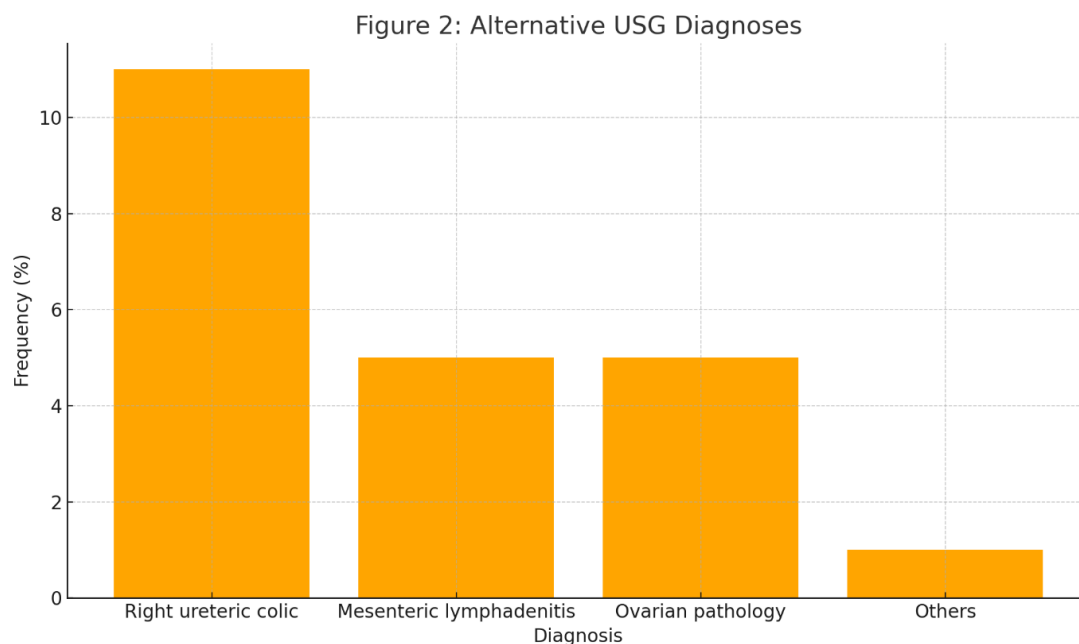


FIGURE 2: ALTERNATIVE USG DIAGNOSES



4. DISCUSSION

Our findings reaffirm the Alvarado score as a valuable adjunct in diagnosing appendicitis, particularly its high PPV of 98 % for scores ≥ 7 . Comparable Indian cohorts have reported PPVs ranging from 86 % to 96 % [10, 11], underscoring the score's reliability in resource-constrained settings. The sensitivity of 71 % in our study, while slightly lower than the 81 % pooled in a meta-analysis of 42 studies [12], reflects real-world variability owing to early patient presentation and heterogeneity in symptom evolution.

Specificity (75 %) mirrored that of Kalan et al. [13], signalling reasonable exclusion capability. The modest NPV (15 %) cautions against dismissing appendicitis in low-score patients, aligning with Wei et al.'s recommendation for observation and repeat imaging in equivocal cases [14]. Importantly, no perforations occurred among conservatively managed patients, highlighting the safety of this algorithm.

Routine USG increased diagnostic confidence, especially in $AS \leq 6$, where 36 % ultimately harboured appendicitis. CT was not used, consistent with institutional policy to minimise radiation in young adults; yet negative appendicectomy rate (6 %) compared favourably with centres employing liberal CT [15]. This supports structured clinical scoring as a gate-keeper to imaging.

The study reinforces the age and sex distribution typical of appendicitis, peaking in the second decade and with male predominance [16]. Symptom frequencies mirrored global patterns, with migratory pain remaining the most discriminating feature [17].

Strengths include prospective design, uniform protocol, blinded histology and complete follow-up. Limitations encompass single-centre scope, limited sample and absence of CT corroboration. The AS cut-off of ≥ 7 , though traditional, may benefit from recalibration using receiver-operating-characteristic analysis to optimise sensitivity. Future multi-centre trials evaluating AS combined with neutrophil-lymphocyte ratio or point-of-care ultrasound may yield composite algorithms with superior accuracy.

Clinically, our data endorse a pathway where $AS \geq 7$ prompts early surgery, $AS 5-6$ warrants observation and imaging, and $AS \leq 4$ supports discharge with safety-netting—potentially reducing ED crowding, hospital costs and operative delays.

5. CONCLUSION

In this prospective Indian cohort, an Alvarado score ≥ 7 demonstrated excellent positive predictive value for acute appendicitis and facilitated safe, timely appendicectomy with a low negative rate. Scores ≤ 6 required adjunctive imaging and observation, preventing unnecessary surgery without compromising patient safety. Integrating the Alvarado score into standard emergency triage protocols can optimise diagnostic efficiency and healthcare resource allocation in settings where advanced imaging is limited.

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