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Functional Outcome of Coronoid Process Fracture Fixed with Suture Anchors

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HIGHLIGHTS

- Coronoid fractures destabilize elbow
- Suture anchors restore stability
- Early mobilization aids recovery
- Favorable functional outcomes observed
- Minimal postoperative complications

Key Words:

Coronoid process fracture
Suture anchor fixation
Terrible triad elbow
HSS elbow score
Functional outcome

ABSTRACT

Introduction: Coronoid process fractures are a key determinant of elbow stability, especially in terrible triad injuries, where disruption of the anterior buttress leads to instability and functional impairment. Suture anchor fixation has gained importance in managing small and comminuted fragments by restoring capsuloligamentous integrity and enabling early mobilization. **Aim & Objective:** To evaluate the functional outcome of coronoid process fractures fixed with suture anchors, with specific assessment of elbow stability, range of motion, HSS elbow score, and postoperative complications. **Materials & Methods:** This observational follow-up study was conducted in the Department of Orthopaedics, Government Medical College, Kottayam, over 16 months after IRB approval. A total of 21 adult patients with terrible triad elbow and Regan Morrey type I and II coronoid fractures were included. All patients underwent coronoid fixation using suture anchors along with appropriate management of radial head fractures and lateral collateral ligament repair. Postoperative immobilization was maintained for two weeks, followed by structured rehabilitation. Patients were followed for six months and evaluated using the HSS elbow score. **Results:** The mean flexion arc was 107°, the mean flexion contracture was 14°, and the mean rotational arc was 131°, indicating satisfactory restoration of motion. The majority of patients achieved functional forearm rotation, and 53% had minimal contracture ($\leq 10^\circ$). HSS scoring showed 14% excellent, 62% good, 9.5% fair, 9.5% poor, and 4.8% failed outcomes, reflecting predominantly favorable recovery. **Conclusion:** Suture anchor fixation of Regan Morrey type I and II coronoid fractures provide stable fixation, facilitates early mobilization, and results in good to excellent functional outcomes, supporting its effectiveness as a minimally invasive technique.



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INTRODUCTION

Fractures of the coronoid process of the ulna represent a relatively uncommon yet clinically critical subset of elbow injuries due to their pivotal role in maintaining joint stability and congruency [1]. The coronoid process forms the anterior portion of the greater sigmoid notch and acts as a key bony stabilizer that resists posterior displacement of the ulna relative to the humerus [2]. In addition to its osseous contribution, it serves as the attachment site for essential soft tissue stabilizers, including the anterior capsule, brachialis muscle, and components of the medial collateral ligament. Any disruption of this anatomical structure, therefore, compromises both static and dynamic stability of the elbow, predisposing to recurrent dislocation, chronic instability, and long-term functional impairment [1].

Coronoid process fractures are most frequently encountered as part of complex injury patterns rather than isolated lesions [3]. They commonly occur in association with elbow dislocations, radial head fractures, or ligamentous injuries, forming the well-known “terrible triad” of the elbow [4]. The incidence of coronoid fractures in elbow dislocations has been reported to range between 2% and 15%, with a significantly higher prevalence in complex fracture-dislocation patterns [5]. The mechanism of injury typically involves axial loading combined with varus or valgus stress and rotational forces, leading to shear or avulsion fractures of varying morphology. The Regan Morrey and O’Driscoll classifications are widely used to categorize these fractures based on fragment size and anatomical location, both of which have important implications for stability and management. Larger fragments are associated with increased instability and poorer functional outcomes if inadequately treated [6]. The management of coronoid fractures has undergone a paradigm shift over recent decades. Earlier approaches often underestimated the importance of small coronoid fragments, leading to con-

servative management in selected cases [1]. However, contemporary biomechanical and clinical evidence has established that even small tip fractures significantly contribute to elbow stability, particularly in the presence of ligamentous disruption [7]. Failure to address these fractures appropriately can result in persistent subluxation, early osteoarthritic changes, & restricted range of motion. Consequently, surgical fixation is now considered the standard of care for displaced fractures and those associated with instability [1].

Various surgical techniques have been described for the fixation of coronoid process fractures, including lag screws, buttress plating, Kirschner wire fixation, suture lasso techniques, and suture anchor fixation [8]. The choice of technique is primarily dictated by fragment size, fracture configuration, bone quality, and associated injuries [9]. While larger fragments can be effectively managed with rigid fixation using screws or plates, smaller or comminuted fragments present a unique challenge due to limited bone stock and difficulty in achieving secure fixation [10]. In such cases, soft tissue based fixation techniques have gained increasing acceptance due to their ability to restore both bony anatomy and capsuloligamentous integrity simultaneously [11].

Suture anchor fixation has emerged as a particularly valuable technique in the management of coronoid fractures, especially for small or comminuted fragments and avulsion injuries [12]. This technique involves the use of anchors inserted into the ulna, allowing sutures to secure the coronoid fragment along with the attached anterior capsule [13]. By re-establishing the anterior buttress and capsular tension, suture anchors contribute to both mechanical stability and biological healing. The method offers several advantages, including minimal hardware prominence, reduced risk of implant-related complications, and preservation of bone stock. It is also technically versatile and can be combined

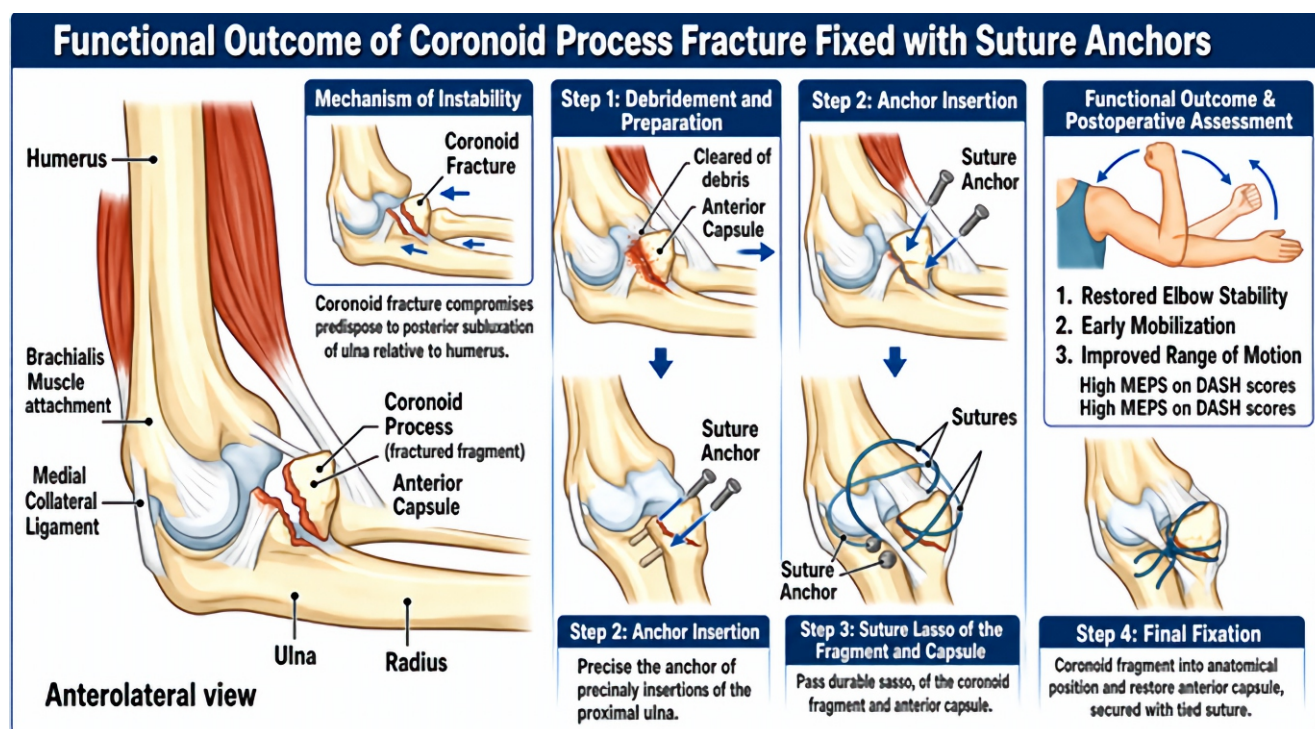


Figure 1. Mechanism, surgical fixation, and functional outcomes of suture anchor repair in coronoid process fractures.

with other fixation methods in complex injury patterns [14].

Functional outcome after coronoid fracture fixation is key to treatment success, aiming to achieve a stable, pain-free, and mobile elbow [15]. Early mobilization is essential to prevent stiffness. Outcomes are assessed using range of motion, pain, stability, and daily function [16]. Standard tools like the Mayo Elbow Performance Score (MEPS) and DASH score quantify recovery. Adequate fixation with management of associated injuries generally results in good to excellent functional outcomes [17].

Recent advances in surgical techniques have emphasized the importance of a comprehensive approach to elbow instability. Isolated fixation of the coronoid process may not be sufficient in cases with associated ligamentous or bony injuries [7]. Repair of the lateral ulnar collateral ligament, reconstruction of the radial head when necessary, and restoration of joint congruity are essential components of successful management [18]. Failure to address these associated injuries can compromise the stability achieved by coronoid fixation and adversely affect functional outcomes. Therefore, a systematic and individualized treatment strategy is required for optimal results [19]. Illustration showing the mechanism of elbow instability in coronoid process fractures, sequential steps of suture anchor fixation including debridement, anchor insertion, fragment stabilization, & capsular repair, along with restoration of elbow stability and postoperative functional outcomes (**Figure 1**).

The aim of this study is to evaluate the functional outcome of coronoid process fractures fixed using suture anchors, particularly in terrible triad injuries of the elbow. The objectives are to assess postoperative elbow stability, range of motion, and functional recovery using the HSS elbow score, and to analyze complications, effectiveness of fixation, and overall clinical outcomes following this surgical technique.

MATERIALS & METHODS

This observational follow-up study was conducted in the Department of Orthopaedics, Government Medical College, Kottayam, over 16 months after IRB approval. Twenty-one adult patients with terrible triad elbow having Regan Morrey type 1 or type 2 coronoid fractures were included. After clinical and CT evaluation, all underwent fixation of the coronoid fracture using suture anchors. Associated radial head fractures were managed according to fracture pattern, and lateral collateral ligament repair was done in all cases. Postoperatively, immobilization was given for two weeks, followed by rehabilitation. Patients were followed for six months, and functional outcome was assessed using HSS elbow score.

RESULTS

The distribution of elbow flexion contracture demonstrates that the majority of patients achieved minimal to mild contracture, with 53% having $\leq 10^\circ$ limitation, indicating satisfactory restoration of elbow motion following suture anchor fixation of coronoid fractures. However, a notable subset (28.5%) exhibited contracture $> 15^\circ$, suggesting residual stiffness likely related to injury severity or delayed mobilization. Overall, the findings indicate that while most patients attain good functional range, a proportion remains at risk for suboptimal motion outcomes (**Table 1**). Most patients achieved functional forearm rotation, with $\approx 62\%$ in the 61° – 70° range, indicating good recovery after suture anchor fixation. Around 24% had moderate motion (50° – 60°), while only $\sim 14\%$ reached near-normal range. Supination and pronation showed similar distribution, reflecting balanced recovery (**Figure 2**). The mean elbow flexion arc of 107° indicates that most patients achieved a functional range of motion adequate for daily activities following suture anchor fixation. The relatively high standard deviation (18.4°) suggests variability in recovery, likely influenced by injury severity or rehabilitation differences. The low standard error (4.1°) reflects reliability of the sample estimate (**Table 2**). The sagittal plane motion distribution shows that the majority of patients ($\approx 76\%$) achieved a flexion arc between 100° – 120° , indicating good functional recovery after fixation (**Figure 3**). The mean flexion contracture of 14° indicates a mild residual loss of extension in most patients following suture anchor fixation. The moderate standard deviation (10.3°) reflects variability in extension recovery, suggesting some patients had greater stiffness. The low standard error (2.25°) supports reliability of the estimate (**Table 3**). The mean rotational arc of 131° indicates good restoration of forearm rotation following suture anchor fixation, sufficient for most functional activities (**Table 4**). The HSS elbow score distribution shows that the majority of patients achieved favorable outcomes, with 76% classified as good to excellent, indicating effective functional recovery following suture anchor fixation. A smaller proportion (19%) had fair to poor results, reflecting suboptimal outcomes in some cases, while 4.8% experienced failure. Overall, the findings demonstrate predominantly satisfactory clinical outcomes with limited poor results (**Table 5**). The HSS score distribution shows that most patients achieved good outcomes (62%), with an additional 14% reaching excellent results, indicating overall favorable functional recovery. A smaller proportion had fair (9.5%) and poor (9.5%) outcomes, while only 4.8% experienced failure. This pattern reflects predominantly satisfactory results with limited adverse outcomes (**Figure 4**).

Table 1: Distribution of Flexion Contracture of Elbow

Flexion Contracture	Frequency	Percentage (%)
0–5°	5	24%
6–10°	6	29%
11–15°	4	19%
15–20°	2	9.5%
>20°	4	19%
Total	21	100%

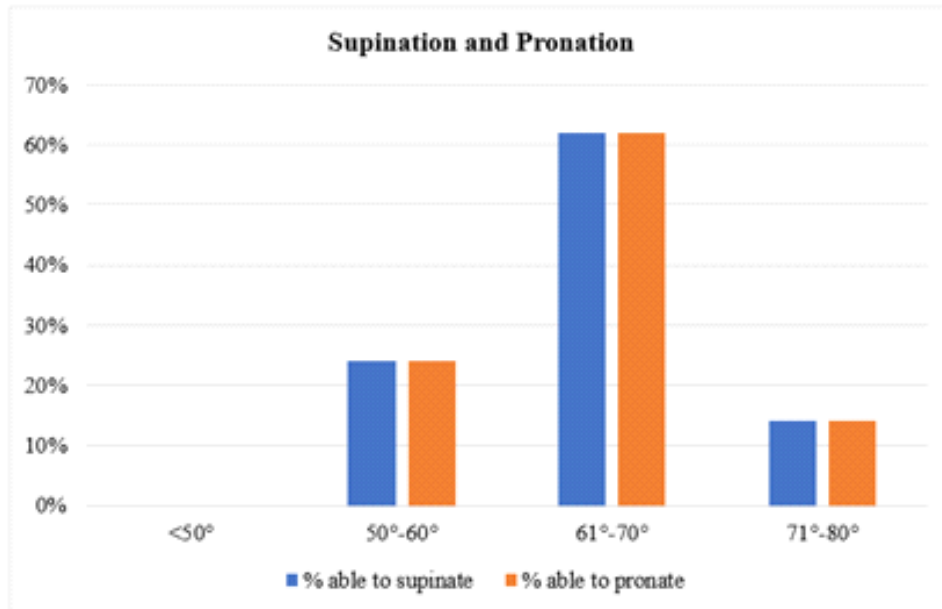


Figure 2: Distribution of Supination and Pronation Range of Motion Among Study Participants

Table 2: Mean Flexion Arc of Elbow

Parameter	Value
Mean Flexion Arc	107°
Standard Deviation	18.4°
Standard Error	4.1°

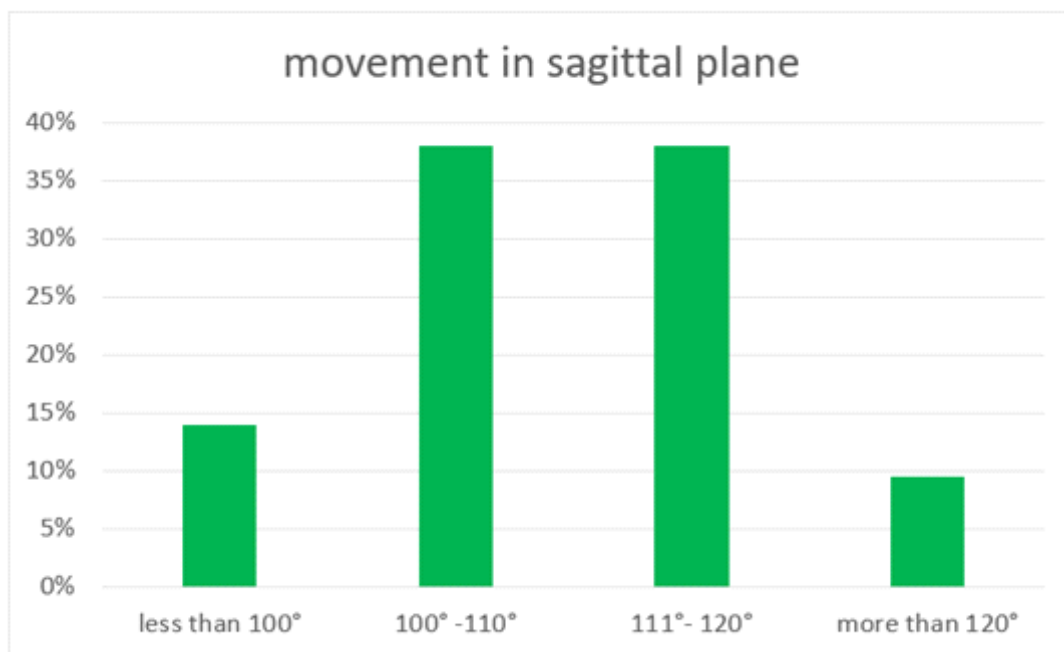


Figure 3: Distribution of Sagittal Plane Range of Motion Among Study Participants

Table 3: Mean Flexion Contracture (Loss of Extension)

Parameter	Value
Mean Flexion Contracture	14°
Standard Deviation	10.3°
Standard Error	2.25°

Table 4: Mean Rotational Arc

Parameter	Value
Mean Rotational Arc	131°
Standard Deviation	15°
Standard Error	3.2°

Table 5: Distribution of HSS Elbow Score

HSS Score	Frequency	Percentage (%)
Excellent	3	14%
Good	13	62%
Fair	2	9.5%
Poor	2	9.5%
Failed	1	4.8%
Total	21	100%

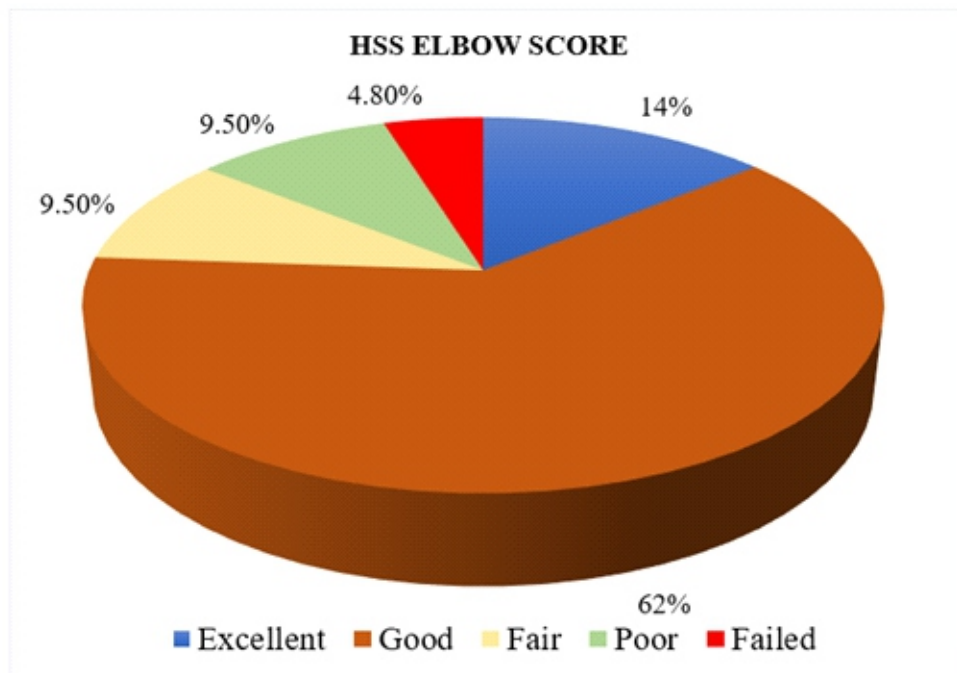


Figure 4: Distribution of Functional Outcomes Based on HSS Elbow Score in Study Population

DISCUSSION

The present study highlights the critical role of the coronoid process as a primary anterior stabilizer of the elbow, essential for maintaining ulnohumeral congruity and preventing post-traumatic arthritis. Morrey et al. demonstrated that at least 50% of coronoid height is required for stability, while in terrible triad injuries, even smaller fractures can lead to instability due to associated ligamentous disruption. Forthman et al. [20] further emphasized that adequate repair of all injured structures, particularly the coronoid, can restore stability without necessitating medial collateral ligament repair or external fixation. Various fixation techniques exist, including screws, K-wires, plates, and suture-based methods; however, suture anchors offer distinct advantages in small or comminuted fragments by providing stronger fixation, reduced dead length, and facilitating early mobilization [20].

In our study, most coronoid fractures were managed via a lateral approach, often combined with radial head fixation through the same incision, while a few required an additional anteromedial approach. The operative protocol aligned with the sequence described by Pugh et al., prioritizing coronoid fixation followed by radial head and ligament repair. Functional outcomes in our cohort demonstrated a mean flexion arc of 107°, flexion contracture of 14°, and rotational arc of 131°, which are comparable to findings by Forthman et al. (117° flexion arc, 137° rotation) and Pai et al. (116° flexion arc). The mean HSS score in our study was 82.4, closely matching Pai et al. (82.5), indicating consistent functional recovery across studies [20,22].

Outcome distribution revealed that the majority of patients achieved good to excellent results, with 3 excellent, 13 good, and only a small proportion demonstrating fair to poor outcomes. These findings are in line with previous literature reporting satisfactory outcomes in the majority of cases, such as Forthman et al. and Pugh et al. Complication rates in our study, including heterotopic ossification, infection, nerve palsy, and stiffness, were comparable to those reported in earlier studies, although variations exist depending on surgical technique and patient factors [20,22].

Importantly, the study reinforces that suture anchor fixation is particularly effective for Regan–Morrey type I and II fractures, where fragment size is small or comminuted. However, in type III fractures with larger fragments, more rigid fixation methods such as screws or buttress plates are required for adequate stabilization. Overall, the findings support that appropriate fixation of the coronoid process, especially using suture anchors in selected fracture types, leads to satisfactory functional outcomes and stable elbow joint restoration, consistent with established evidence from Forthman et al., Pugh et al., and Pai et al [20-22].

CONCLUSION

In conclusion, fixation of Regan–Morrey type 1 and type 2 coronoid process fractures using suture anchors in terrible triad elbow provides satisfactory stability and facilitates early mobili-

zation. The study demonstrated good functional outcomes, with most patients achieving good to excellent HSS elbow scores and acceptable range of motion. The technique proved to be simple, minimally invasive, and effective, with low incidence of instability. Suture anchor fixation also aids in capsular repair, enhancing joint stability. However, outcomes may be limited by factors such as small sample size, and further comparative studies with larger populations are recommended.

LIMITATIONS & FUTURE PERSPECTIVES

The study's limitations include a single-centre setting, a relatively small sample size, and a short study duration, which may limit the broader applicability of the results. Future studies should incorporate multicentre designs with larger populations to enhance validity, assess long-term outcomes, and investigate advanced diagnostic & management approaches. Such efforts will improve overall patient care and help minimize complications.

CLINICAL SIGNIFICANCE

The clinical significance of this study lies in its potential to bridge the gap between research findings and practical healthcare applications. It emphasizes the importance of translating scientific observations into meaningful improvements in patient care, diagnosis, and treatment outcomes. By highlighting real-world relevance, the study contributes to evidence based medical practice and supports informed clinical decision making. Ultimately, the findings aim to enhance patient quality of life, optimize therapeutic strategies, and promote better disease management in clinical settings.

ABBREVIATIONS

HSS: Hospital for Special Surgery

K-wires: Kirschner wires

MCL: Medial collateral ligament

ROM: Range of motion

TTI: Terrible triad injury

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AUTHOR CONTRIBUTIONS

All authors significantly contributed to the study conception and design, data acquisition, or data analysis and interpretation. They participated in drafting the manuscript or critically revising it for important intellectual content, consented to its submission to the current journal, provided final approval for the version to be published, and accepted responsibility for all aspects of the work. Additionally, all authors meet the authorship criteria outlined by the International Committee of Medical Journal Editors (ICMJE) guidelines.

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CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

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CONSENT FOR PUBLICATION

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DATA AVAILABILITY

All data generated and analyzed are included within this research article. The datasets utilized and/or analyzed in this study can be obtained from the corresponding author upon a reasonable request.

USE OF ARTIFICIAL INTELLIGENCE (AI) & LARGE LANGUAGE MODEL (LLM)

The authors confirm that no AI & LLM tools were used in the writing or editing of the manuscript, and no images were altered or manipulated using AI & LLM.


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