FUNCTIONAL OUTCOMES AND TENDON HEALING FOLLOWING ARTHROSCOPIC SINGLE-ROW REPAIR OF LARGE AND MASSIVE ROTATOR CUFF TEARS

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ABSTRACT

Introduction: Large and massive rotator cuff tears frequently cause pain, functional limitation, and weakness. Single-row arthroscopic repair is widely performed due to its technical simplicity and cost-effectiveness. The study aims to evaluate functional outcomes, tendon healing, and structural changes following single-row repair of large and massive rotator cuff tears. **Methods:** We retrospectively analyzed 44 patients (23 men, 21 women; mean age 62 ± 7.4 years) who underwent arthroscopic single-row repair between 2021 and 2024. Preoperative assessment included tear size, tendon retraction (Patte), fatty infiltration (Goutallier), and tangent sign. Functional outcomes were measured using UCLA Shoulder Rating Scale and VAS. Postoperative tendon healing was assessed in 22 patients (50% of the cohort) via MRI. **Results:** Mean follow-up was 20.2 months. UCLA scores improved from 13.6 ± 2.9 to 30.3 ± 2.5, and VAS decreased from 7.4 ± 0.6 to 2.5 ± 0.9 ($p < 0.001$). Complete repair was achieved in 65.9% of cases; medialization (<10 mm) in 63.6%. MRI showed 38.3% intact tendons (Sugaya I–II) and 61.7% partial/full-thickness defects (Sugaya III–V). Some patients demonstrated improved tendon retraction and apparent improvement in fatty infiltration. No major complications were observed. **Conclusions:** Single-row arthroscopic repair significantly improves function and reduces pain in large and massive rotator cuff tears. Despite a moderate re-tear rate, tendon quality and fatty degeneration may improve, supporting single-row repair as a clinically effective option when double-row repair is not feasible.

***Keywords**: Rotator cuff tear, Single-row repair, Arthroscopy, Fatty degeneration, Medialization*

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I. INTRODUCTION

Rotator cuff tears are common shoulder disorders whose prevalence increases with age, affecting approximately 30% of individuals older than 60 years and up to 62% of those over 80 years. These tears commonly cause shoulder pain, weakness, limited abduction and external rotation, difficulty with overhead activities, and reduced quality of life (1). According to the DeOrio and Cofield classification, large tears measure 3–5 cm, whereas massive tears are defined as tears >5 cm or involving two or more tendons. Tear size is assessed intraoperatively after debridement of degenerative tissue. Large and massive tears account for 20–40% of all rotator cuff tears and more than half of symptomatic full-thickness tears requiring surgery. If untreated, they may progress and result in substantial shoulder dysfunction (1,2). Treatment selection depends on tear size, tendon retraction, fatty infiltration, chronicity, patient age, and functional demand. Available surgical options include arthroscopic debridement and repair, tendon transfer, superior capsular reconstruction, and reverse shoulder arthroplasty (1).

Previous studies have shown no significant difference in functional outcomes between single-row and double-row repair techniques. Although double-row repair may improve tendon healing and reduce retear rates, single-row repair remains more cost-effective and technically simpler (2,3). This is particularly important in resource-limited settings and in cases with severe tendon retraction or fatty degeneration, where double-row fixation may be impractical or excessively tension the repair (4). Therefore, single-row repair continues to have important clinical value. This study evaluates functional outcomes and retear rates after arthroscopic single-row repair of large and massive rotator cuff tears.

II. MATERIALS AND METHODS

This study was approved by the Institutional Review Board of the University of Medicine and

Pharmacy at Ho Chi Minh City (Approval No. 159/ĐHYD - HĐĐĐ) and conducted in accordance with the Helsinki Declaration and relevant ethical guidelines. Informed consent was obtained as per institutional requirements.

Study Design: This retrospective descriptive study reviewed all patients diagnosed with large or massive rotator cuff tears who underwent arthroscopic single-row rotator cuff repair at Saigon-ITO Phu Nhuan Hospital between January 2021 and December 2024. The study was conducted according to STROBE guidelines for observational research.

Patient Selection: eligible cases were identified through operative records, surgical scheduling databases, and electronic medical records. All patients who underwent arthroscopic rotator cuff repair during the study period were screened. Diagnosis of a large or massive tear was pre-defined by preoperative MRI based on established size criteria and confirmed by intraoperative findings described in operative reports.

Inclusion Criteria: Adults aged 18 years or older who underwent primary arthroscopic single-row repair for a confirmed large or massive rotator cuff tear, as classified intraoperatively by the Cofield system during the study period were included. Operative notes and imaging had to be available to verify tear size and surgical technique, and patients were required to have a minimum follow-up of six months postoperatively.

Exclusion criteria: Patients were excluded if they underwent revision rotator cuff repair, repairs using double-row, suture-bridge, transosseous-equivalent, mini-open, or open techniques, or had rotator cuff tears associated with acute proximal humeral fractures or fracture-dislocations. Those undergoing concomitant major surgical procedures likely to affect postoperative outcomes, such as shoulder arthroplasty, or with incomplete or missing clinical, imaging, or operative data, were also excluded. Additionally, patients who declined the use of their clinical information for research were not included.

Surgical Technique: All procedures were performed arthroscopically with the patient in the lateral decubitus position under general anesthesia. Controlled hypotension was maintained intraoperatively, with systolic blood pressure stabilized between 90 and 100 mmHg. The trunk was tilted posteriorly by approximately 20°, and the arm was abducted to 30°. A traction force of 4–5 kg was applied using a dedicated arm traction system to facilitate optimal visualization and working space within the glenohumeral and subacromial compartments.

Diagnostic and Therapeutic Arthroscopy:

- Standard posterior, anterior, and lateral portals were established to explore the glenohumeral joint and the subacromial space, assess the rotator cuff tear, and identify any associated lesions. Tear location, configuration, pattern, size, tendon retraction, and reparability were carefully evaluated.

- Posterior portal: Located approximately 1.5 cm inferior and 1 cm medial to the posterolateral corner of the acromion, or at the point of maximal soft-tissue depression posterior to the joint.

- Anterior portal: Positioned lateral to the coracoid process and created using an outside-in technique by introducing a spinal needle into the triangle bordered by the long head of the biceps tendon, the subscapularis tendon, and the anterior glenoid rim under visualization from the posterior portal.

- Lateral portal: Established 2–3 cm lateral to the acromion along a perpendicular line drawn from the junction of the clavicle and the scapular spine, confirmed by inserting a spinal needle toward the center of the tear.

- Posterolateral portal: Commonly used for complete cuff tears, placed at the posterior margin of the supraspinatus/infraspinatus tear, close to the lateral acromial border, and localized with a spinal needle.

- Accessory portals for anchor placement were created as needed, guided by spinal needle localization to achieve an insertion angle of approximately 45° to the footprint. Single-row repair was performed using 1–3 suture anchors depending on tear size and tendon quality. Sutures were passed in simple or mattress configurations.

Intraoperative Assessment

- The integrity of the long head of the biceps tendon, the presence of superior labrum anterior-to-posterior (SLAP) lesions, the glenoid labrum, and the articular cartilage were

evaluated arthroscopically. The subacromial space was then entered, inflammatory tissue was debrided, and acromioplasty was performed if subacromial narrowing was present to create adequate working space. After debridement, the tear was carefully assessed for morphology, size, degree of tendon retraction, and intraoperative tendon quality.

- Complete repair was attempted when the tendon could be reduced without excessive tension. When this was not achievable, partial repair or footprint medialization (<10 mm) was performed to achieve low-tension fixation.

Data Collection: Data extraction was collected using a standardized form developed prior to the chart review. Two independent reviewers recorded all variables, with discrepancies resolved by consensus with a senior investigator. Data were obtained from the hospital's medical records, operative reports, PACS (Picture Archiving and Communication System), and physiotherapy notes.

The following data elements were obtained: Demographic and baseline data, including age, sex, dominant side, and affected shoulder were recorded. Clinical information contained the symptom duration and preoperative Visual Analog Scale (VAS). Imaging parameters included tear size, tendons involved, Patte retraction grade, Goutallier fatty infiltration, tangent sign, remaining tendon length and thickness. Operative details covered surgery date, confirmation of single-row technique, tendon mobility, tear size after debridement, and concomitant procedures such as biceps tenotomy, acromioplasty, or medialization of the tendon footprint (<10 mm when necessary). Outcomes comprised postoperative VAS, University of California-Los Angeles (UCLA) shoulder rating scale, and follow-up duration. Complications documented included stiffness, infection, anchor failure, re-tear, readmission, and reoperation.

Using SPSS software, patients were selected by simple random sampling with a computer-generated random number sequence and invited for follow-up shoulder MRI to assess tendon healing using Sugaya classification, and quality postoperatively. All patients' data were de-identified for confidential reasons.

Statistical Analysis: Statistical analysis was performed using SPSS software (version 20.0; IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation. Categorical variables were summarized as frequencies and percentages. Comparisons between groups were conducted using the independent-samples t-test for continuous variables and the chi-square test for categorical variables. A p-value < 0.05 was considered statistically significant.

III. RESULTS

Between January 2021 and December 2024, 49 patients with large or massive rotator cuff tears underwent arthroscopic single-row repair (Figure 1). Five patients were lost to follow-up, resulting in a final study population of 44 patients. The mean follow-up period was 20.2 months (range, 6–42 months), data collection was from January to August 2025.

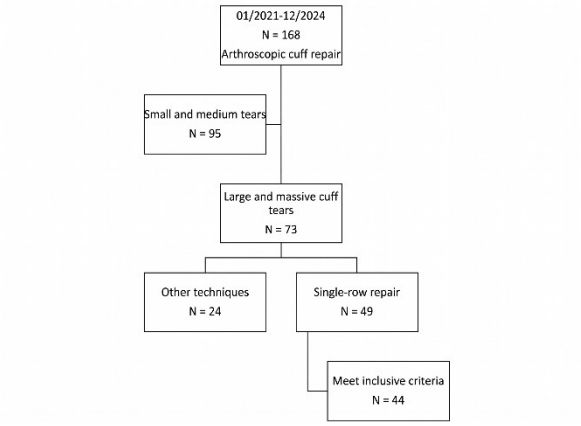

Figure 1. Patient Selection Flowchart

The study cohort included 23 men and 21 women, with a mean age of 62 ± 7.4 years (range, 46 - 74 years old). Most patients were ≥60 years (61.4%). The right shoulder was involved in 28 patients (63.6%) and the left in 16 patients (36.4%). Most tears were degenerative (54.5%) rather than traumatic (45.5%). Symptom duration averaged 10.4 ± 12.5 months. Preoperative UCLA score averaged 13.6 ± 2.9 (range, 7 - 18) and VAS pain score averaged 7.4 ± 0.6 (range, 6 - 9). Imaging showed complete rotator cuff tear with Patte grade 2 retraction in 70.5% and grade 3 in 29.5% (Table 1). Fatty infiltration (Goutallier) was mostly grade 1–2 (86.4%), with grade 3–4 in 13.6%. Tangent sign was positive in 22.7%. Mean remaining tendon thickness was 6.6 ± 1.0 mm and length 25.5 ± 5.0 mm.

Table 1. Tear characteristics

Variable	Category	Value
Goutallier classification	Grade I	43.2%
	Grade II	43.2%
	Grade III	11.3%
	Grade IV	2.3%
Tangent sign	Positive	22.7%
	Negative	77.3%
Patte classification	Grade I	0
	Grade II	70.5%
	Grade III	29.5%

Intraoperative findings: The mean intraoperative rotator cuff tear size measured 33.48 ± 7.69 mm (Figure 2). 61.4% were large tears and 38.6% massive tears. Complete repair was achieved in 65.9% of patients, predominantly in large tears and those with lower fatty degeneration or less tendon retraction. Medialization (<10 mm) was performed in 63.6% of cases. Concomitant procedures included biceps tenotomy (29.6%) and acromioplasty (47.7%).

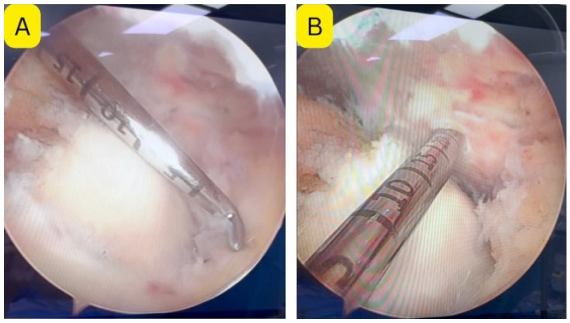

Figure 2. Tear size was intraoperatively measured in the mediolateral (A) and anteroposterior (B) dimensions**.**

Functional outcomes: Postoperative improvements were significant. Mean UCLA score increased from 13.6 ± 2.9 pre-op to 30.3 ± 2.5 post-op ($p < 0.001$), with 84.1% achieving good to excellent outcomes. Pain (VAS) decreased from 7.4 ± 0.6 to 2.5 ± 0.9 ($p < 0.001$). All components of UCLA (pain, function, ROM, strength, satisfaction) improved significantly (all $p < 0.001$).

Subgroup analysis revealed that patients with large tears had higher postoperative UCLA scores (31.2 ± 2.4) and lower VAS pain scores (2.3 ± 0.8) compared to those with massive tears (UCLA 28.8 ± 2.1, VAS 2.9 ± 0.9; $p = 0.0018$ and $p = 0.0104$, respectively). Complete repairs achieved superior outcomes (UCLA 31.3 ± 2.2, VAS 2.2 ± 0.7) compared with partial repairs (UCLA 28.1 ± 1.6, VAS 3.1 ± 1.0; $p < 0.001$ and $p = 0.004$, respectively). Patients requiring medialization had lower UCLA scores (29.4 ± 2.5) and higher VAS scores (2.9 ± 0.9) than those without medialization (UCLA 31.8 ± 1.8, VAS 1.9 ± 0.6; $p = 0.0018$ and $p < 0.001$, respectively). Acromioplasty was associated with slightly lower UCLA scores (29.1 ± 2.6 vs 31.2 ± 2.1; $p = 0.0044$) and higher VAS scores (2.9 ± 0.9 vs 2.2 ± 0.7; $p = 0.009$). Biceps tenotomy status did not significantly affect postoperative UCLA or VAS outcomes. A moderate positive correlation was found between the need for footprint medialization and tear size, Patte grade, Goutallier grade, and tangent sign ($r = 0.41–0.58$), with tear size showing the strongest association. Also, tear size showed a moderate correlation with both Patte and Goutallier classifications, with Patte grade exerting a greater influence.

Complications: No major postoperative complications occurred. Four intraoperative anchor failures were observed, likely related to bone quality, and were managed intraoperatively without affecting outcomes. Minor swelling occurred in 15.9% and transient limited shoulder motion in 13.6%, all of which resolved with rehabilitation.

Postoperative MRI (n = 22, 50% randomly selected): Tendon healing assessed by Sugaya classification showed 38.3% with intact tendon (type I–II) and 61.7% with partial or full-thickness defects (type III–V). Notably, four patients with preoperative large rotator cuff tears and Goutallier grade 3 fatty degeneration showed retears, but only grade 2 fatty degeneration (Figure 3). No significant differences were found between MRI and non-MRI groups in baseline characteristics (all $p > 0.05$), although selection bias cannot be excluded.

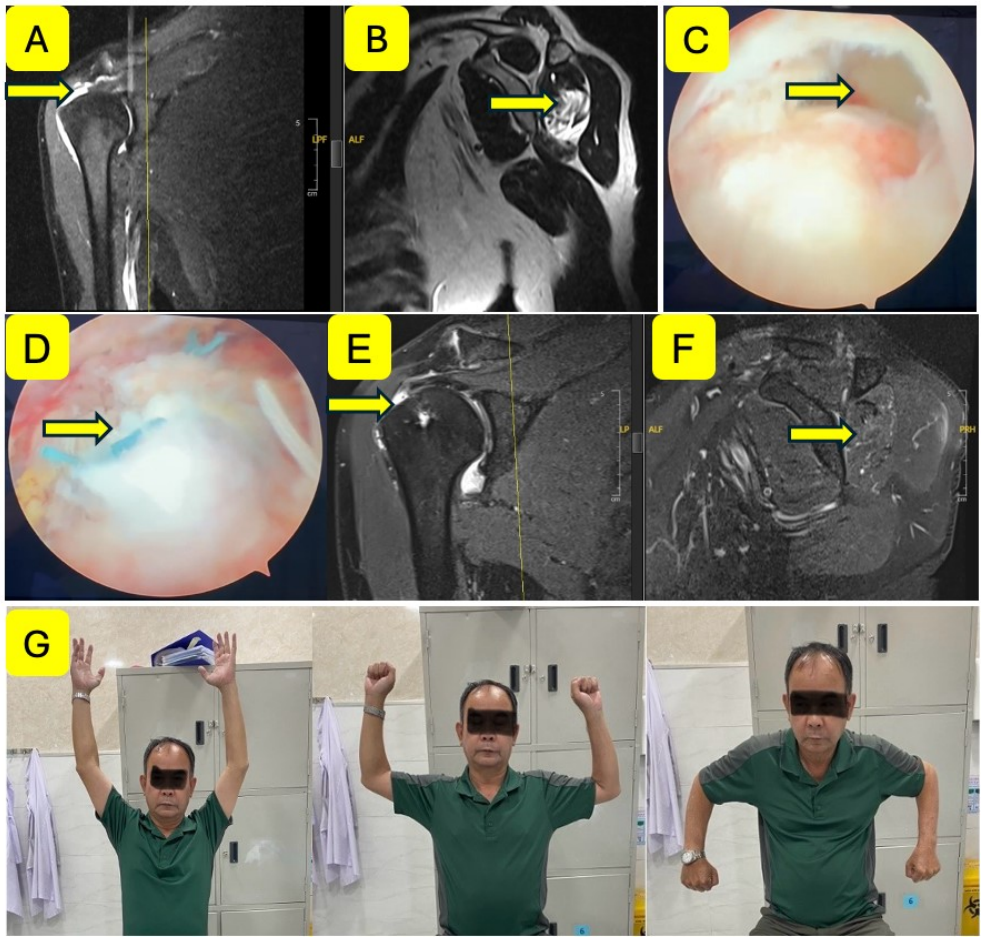

Figure 3. 61 years old man, (A) MRI shows large full-thickness rotator cuff tear, right shoulder, (B) Goutallier grade 3 fatty degeneration, (C) 4 cm of crescent-shaped tear of the supraspinatus and infraspinatus tendons, (D) Single-row complete repair, (E) 39 months postoperative MRI shows less retracted retear, (F) 39 months postoperative MRI shows Goutallier grade 2 fatty degeneration, (G) Full ROM without pain at 39 months post operation.

IV. DISCUSSION

Our study demonstrates that arthroscopic single-row rotator cuff repair remains a relevant and effective surgical option for large and massive tears, producing significant improvements in shoulder function and pain relief. Our findings showed a marked increase in mean UCLA scores from 13.6 ± 2.9 to 30.3 ± 2.5 and a reduction in VAS scores from 7.4 ± 0.6 to 2.5 ± 0.9 at final follow up, indicating substantial clinical improvement. Notably, 84.1% of patients achieved good to excellent functional outcomes, affirming that single-row repair provides meaningful benefits in appropriately selected cases.

The current literature supports that functional outcomes may not differ significantly between single and double row repair techniques, especially when measured with validated clinical scores such as UCLA, the American Shoulder and Elbow Surgeons (ASES), or Constant scores (1). Similarly, systematic reviews report that although double-row repair can obtain a higher tendon healing rate and lower re-rupture rate, the impact on patient-reported function is often limited or not clinically significant in many comparative studies. In fact, meta-analyses show that double row repair tends to achieve superior structural outcomes with improved tendon integrity and reduced re-tear risk, particularly for tears greater than 3 cm, but without consistent superiority in functional scores

across all studies (3). In our study, although intact tendon healing on MRI was achieved in only 38.3% of randomly selected patients, the functional results remained favorable. Functional improvement despite structural failure may be explained by pain relief, restoration of force couple balance, and partial tendon continuity, rather than complete anatomical healing. This reinforces the concept that healing integrity, as seen on imaging, does not always directly correspond to clinical function, a phenomenon described in multiple outcomes studies (5,6). Besides, re-tear rates remain a notable concern with single row repair, consistent with prior literature identifying higher re-tear incidence compared with double row configurations, especially for larger tears. Despite this, improvements in residual tendon quality, retraction, and even apparent improvement in fatty infiltration were observed in our selected cases (Figure 3), suggesting that some degree of structural adaptation and favorable tissue response can occur after repair. This finding should be interpreted cautiously, as Goutallier grading is known to have moderate interobserver variability.

Additionally, tear size showed a moderate correlation with both Patte and Goutallier classifications, with Patte grade presenting a greater influence. In contrast, Goutallier classification appeared relatively less predictive of repair difficulty or postoperative outcome. These results align with Eugene Kim's observation that supraspinatus muscle quality deteriorates with age and defect size, yet nearly half of the largest tears retain good muscle integrity (7). This highlights the distinction between acute traumatic ruptures and chronic degenerative tears, emphasizing that not all large lesions share the same biological characteristics. Similarly, moderate positive correlation was observed between the need for footprint medialization and tear size, Patte grade, Goutallier grade, and tangent sign ($r = 0.41–0.58$), with tear size showing the strongest association. This suggests that tendon retraction, as reflected by tear size, is the primary factor influencing the decision for medialization, while other variables play a lesser role. Although all factors inform surgical planning, tear morphology and degree of retraction appear to be the most critical predictors of medialization requirements. Clinically, these findings suggest the importance of evaluating tendon retraction and defect size over fatty infiltration when planning arthroscopic repair, ensuring medialization is applied reasonably to optimize tendon healing and functional outcomes.

Footprint medialization served as an effective strategy to achieve low tension tendon fixation in severely retracted tears that were otherwise difficult to repair anatomically (8). Although medialized repairs showed slightly lower UCLA and higher VAS scores compared with non-medialized repairs, mean outcomes remained clinically satisfactory. This supports the continued use of medialization as a surgical adjunct in complex tear patterns where direct anatomical repair under acceptable tension is not feasible. By enabling secure tendon fixation under reduced tension, medialization promotes biological tendon healing and supports satisfactory restoration of shoulder function, even when the repair is positioned medial to the native footprint.

Finally, single-row arthroscopic repair continues to hold an important role in the surgical management of large and massive rotator cuff tears. While double row techniques may offer some structural advantages, clinical function and pain relief after single row repair are comparable, and favorable outcomes can be achieved even in cases with tendon retraction or fatty degeneration when appropriate surgical techniques, including medialization, are implemented.

Our study has several limitations. First, it is a retrospective, single-center study, which may introduce selection bias and limit the generalizability of the findings. Second, the sample size is relatively small, particularly for subgroup analyses and postoperative MRI evaluation, which may affect the statistical power. Third, postoperative tendon integrity was assessed in only 50% of patients, potentially underrepresenting re-tear rates. Fourth, functional outcomes relied primarily on patient-reported measures (UCLA and VAS scores), without independent strength testing or objective biomechanical assessment. Finally, our study did not include a comparative group with double-row repair; therefore, conclusions regarding superiority over double-row repair cannot be drawn.

V. CONCLUSION

Arthroscopic single-row repair is an effective and clinically relevant technique for managing large and massive rotator cuff tears. The procedure provides significant improvements in shoulder function and pain relief, with postoperative outcomes consistent with previous literature reporting comparable functional outcomes. While the re-tear rate remains relatively high, the repair can improve tendon retraction, supporting tendon quality and functional recovery. Tear size shows a stronger correlation with Patte than Goutallier classification, indicating tendon retraction is more critical than muscle degeneration for planning repair and predicting functional recovery. Footprint medialization is a valuable adjunct for severely retracted tears, enabling low-tension fixation without compromising overall clinical outcomes.

DECLARATION OF INTEREST:

The authors declare that they have no conflicts of interest related to this study. No financial, personal, or professional relationships influenced the conduct or reporting of this research.

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AUTHOR CONTRIBUTIONS:

Duong Minh Nguyen and Hieu Trung Nguyen led conceptualization; data curation was performed by Duong Minh Nguyen, Bao Van Thai Dinh, and Can Viet Le; formal analysis by Duong Minh Nguyen, Bao Van Thai Dinh, and Phu Hoang Nguyen; methodology by Duong Minh Nguyen, Hieu Trung Nguyen, and Hung Phuoc Do; software by Bao Van Thai Dinh; validation by Duong Minh Nguyen, Bao Van Thai Dinh, Phu Hoang Nguyen, and Can Viet Le; investigation by Hieu Trung Nguyen and Bao Van Thai Dinh; drafting by Duong Minh Nguyen, Bao Van Thai Dinh, and Hieu Trung Nguyen; and all authors contributed to review and editing.

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