The Philippine Journal of Orthopaedics

CASE SERIES

Achilles Tendon Rupture Repair Using Knotless Unidirectional Absorbable Barbed PDS Suture: A Prospective Case Series of Five Patients

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ABSTRACT

This was a case series of five patients with closed Achilles tendon rupture between 2023 and 2024, with a mean follow-up of six months. The objective was to evaluate the applicability of knotless absorbable barbed sutures in the management of Achilles tendon rupture through short- to mid-term clinical and functional outcomes. All patients underwent open end-to-end tendon repair using the modified Bunnell technique with a total of six cores, with a size 1 knotless, unidirectional, absorbable barbed PDS suture, via the posteromedial approach. Surgeries were performed by multiple surgeons at Jose R. Reyes Memorial Medical Center, a tertiary hospital. Post-operative American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score and 36-Item Short Form Health Survey (SF-36) score were monitored. All five patients were satisfied, did not have wound complications or re-operations, and had negative Thompson and Matles tests with no limitation in ankle range of motion at six months. AOFAS score showed a mean difference of 62 at six months post-operative, indicating better foot and ankle function, reduced pain, and improved overall mobility. The SF-36 score showed a mean difference of 46, indicating better overall health-related quality of life, reflecting improvements in physical functioning, mental health, social functioning, and overall well-being. Knotless, unidirectional, absorbable barbed PDS suture using the modified Bunnell stitch is a novel and reproducible treatment option for closed Achilles tendon ruptures, providing good clinical and functional outcomes.

Keywords. Achilles tendon rupture, open tendon repair, absorbable barbed suture, modified Bunnell, suture techniques, treatment outcome

INTRODUCTION

The Achilles tendon is the largest and strongest tendon in the human body. It enables the triceps surae to plantarflex the foot, allowing locomotion and propulsion, such as in walking, running, and jumping. Despite its size and strength, it is susceptible to damage and rupture with repetitive use.[1]

Surgery is the gold standard of treatment for patients with Achilles tendon rupture, involving the re-approximation of ruptured tendon ends using various suture materials and techniques. The goal is to restore the resting and proper tension length of the triceps surae to allow return to pre-injury state. Deng et al. demonstrated higher rates of re-rupture with conservative management when compared with both open and minimally invasive repair.[2] Furthermore, when conservative treatment is delayed, or the patient is non-adherent, surgery may still be needed.[3] Traditionally, non-absorbable sutures are used with interlocking techniques for cost-effective and reliable management.[4] In our institution, Ethibond and Fiberwire are most commonly used. However, these have shown an increased incidence of surgical site infections in the

ISSN 0118-3362 (Print)
eISSN 2012-3264 (Online)
Printed in the Philippines.
Copyright© 2026 by Co et al.
Received: September 4, 2026
Accepted: October 14, 2026
Published Online: November 9, 2026
https://doi.org/10.69472/poai.2026.18528

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form of suture granulomas during short- to mid-term follow-up, requiring readmission and/or re-operation.

Kanz et al. evaluated the biomechanical parameters of a knotless absorbable barbed PDS suture in human cadaveric Achilles tendon models.[5] The barbed design prevented gap formation, with significantly less failure strength and similar stiffness to a conventional Fiberwire repair. It is absorbable after 180 to 210 days, theoretically preventing long-term complications such as infection from suture granulomas, as observed with non-absorbable sutures.

OBJECTIVES

To evaluate the short- to mid-term clinical and functional outcomes of open Achilles tendon repair using an absorbable barbed PDS suture with the modified Bunnell technique. To assess the clinical application of Kanz et al.'s innovative biomechanical study on knotless absorbable barbed sutures for the treatment of Achilles tendon rupture in a tertiary hospital setting.

METHODOLOGY

Research design

This was a prospective case series evaluating the effectiveness of knotless, unidirectional, absorbable barbed PDS suture in open repair of closed Achilles tendon rupture seen in a tertiary hospital between 2023 and 2024.

Subject recruitment

Purposive sampling was utilized in the recruitment of the patients. Informed consent was obtained from all prospective participants. The inclusion and exclusion criteria are shown in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion	Exclusion
• Conscious patients, GCS 15 • Adult (Age >18 years and <65 years old) • Closed Achilles tendon rupture with surgical indication	• Polytrauma or multiply injured patient • Open wounds or ongoing infection • Amenable for conservative management

Procedure

Approval from the Institutional Review Board was obtained. After initial evaluation through history, physical examination, and imaging, consent and assent were secured before undergoing surgery. Patients were informed thoroughly regarding the new technique. All the possible risks and complications were explained. For patients who met the inclusion criteria, consent to participate in this study was obtained.

Patients were admitted and scheduled for elective surgery for open Achilles tendon repair using absorbable barbed PDS suture. Multiple surgeons performed the procedures at Jose R. Reyes Memorial Medical Center, a tertiary hospital. All five patients were followed up every two to four weeks, up to six months.

Data analysis

The patients' gait, ankle range of motion, and ability to do squats, jump, and tip-toe were assessed. The mean functional outcome scores using the AOFAS hindfoot score and SF-36 score were recorded pre-operatively, at four weeks post-operatively, and six months post-operatively.

The American Orthopaedic Foot and Ankle Society (AOFAS) score is a clinical scoring system used to evaluate foot and ankle function. It assesses pain, function, and alignment, with scores ranging from 0 to 100 points, with higher scores indicating better outcomes. The Short Form Health Survey (SF-36) is a widely used questionnaire measuring overall health-related quality of life. It evaluates the domains of physical functioning, role limitations (physical and emotional), bodily pain, general health, vitality, social functioning, and mental health. Scores range from 0 to 100, with higher scores indicating better health status. The mean difference between pre-operative and six months post-operative scores was computed.

Case 1

KR was a 24-year-old male who sustained a left closed Achilles tendon rupture two weeks prior while playing basketball. The patient was running on the court, and upon push-off to initiate a jump, he suddenly felt a pop in his left ankle, resulting in immediate pain and swelling. He consulted at a different institution where a musculoskeletal ultrasound showed complete separation of the Achilles tendon with a gap measuring 1.1 cm. On physical examination, the patient's left ankle was tender and swollen, with a palpable gap. The Thompson and Matles tests were positive (Figure 1). Radiographs were normal. The pre-operative AOFAS hindfoot score was 34% at the time of first consult (Table 2), with an SF-36 mean score of 55%.

Case 2

JA was a 29-year-old male, production staff, who sustained a right closed Achilles tendon rupture while playing basketball. He pivoted on his right foot and felt a pop, resulting in sudden pain and inability to ambulate. He consulted at a local center, where radiographs showed no fractures. The patient was sent home without immobilization. Persistence of symptoms prompted a consult at our institution at one week post-injury. On physical examination, there was bruising and tenderness. The Thompson test was positive (Figure 2). The pre-operative AOFAS hindfoot score was 13% at the time of first consult, with an SF-36 mean score of 28%.

Case 3

JD was a 45-year-old male who sustained a left closed Achilles tendon rupture while playing badminton. The patient was running towards the shuttlecock when he had an error in his footwork, causing him to fall on his right side. He heard a pop with immediate pain in his left ankle. On physical examination, the patient had a palpable gap on his posterior ankle, with positive Thompson and Matles tests. The pre-operative AOFAS hindfoot score was 37% at the time of first consult, with an SF-36 mean score of 40% (Table 3).

Case 4

RR was a 46-year-old male, a radiology technician, who sustained a right closed Achilles tendon injury during a basket-

Table 2. Case 1 Pre-operative AOFAS Score Breakdown

AOFAS Ankle-Hindfoot Score Summary

Section 1: Pain Moderate, daily	(20 points)
Section 2: Activity limitations, support requirements Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	(0 points)
Section 2: Maximum walking distance, blocks Less than one	(0 points)
Section 2: Walking surfaces Severe difficulty on uneven terrain, stairs, inclines, ladders	(0 points)
Section 2: Gait abnormality Marked	(0 points)
Section 2: Sagittal motion (flexion plus extension) Severe restriction (less than 15 degrees)	(0 points)
Section 2: Hindfoot motion (inversion plus eversion) Normal or mild restriction (75% - 100% normal)	(6 points)
Section 2: Ankle-hindfoot stability (anteroposterior, varus-valgus) Stable	(8 points)
Section 3: Alignment Poor, nonplantigrade foot, severe malalignment, symptoms	(0 points)

Pertinent Negative | Pertinent Positive | Pertinent Positive

AOFAS Ankle-Hindfoot Score: 34/100 points or 34 percent.

Graphical AOFAS Ankle-Hindfoot Score

Table 3. Case 3 Pre-operative SF-36 Score Breakdown

Physical functioning	10%
Role limitations due to physical health	0%
Role limitations due to emotional problems	0%
Energy/ fatigue	55%
Emotional well-being	60%
Social functioning	62.5%
Pain	55%
General health	70%
Health change	50%
Mean	40.3%



Figure 1. Positive Matles test on the left ankle of Case 1 (posterior view, patient prone with knees flexed to 90 degrees).



Figure 2. Positive Thompson test on the right ankle of Case 2 before **(A)** and during **(B)** calf compression, showing no ankle plantarflexion (lateral view, patient prone with knee flexed).

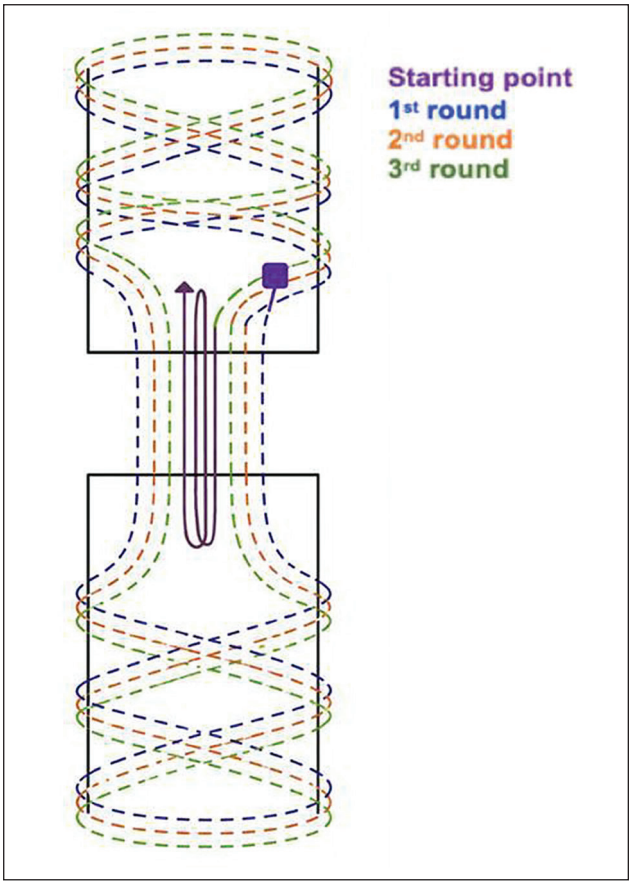


Figure 3. Schematic of the modified Bunnell repair technique showing the starting point and the first, second, and third suture rounds.

ball game. He suddenly felt a popping sensation in his right ankle while landing from a jump after a shot. He was unable to ambulate afterwards. He consulted with a general physician three days post-injury. The patient consulted at our institution at three weeks post-injury for a second opinion. Physical examination showed positive Thompson and Matles tests with ankle plantarflexion limited to 30 degrees. The pre-operative AOFAS hindfoot score was 41% at the time of first consult, with an SF-36 mean score of 46%.

Case 5

BB was a 37-year-old male, seaman, known case of left closed Achilles tendon rupture s/p open Achilles tendon repair using Fiberwire via Krakow technique. At one week post-operatively, the patient was going down the stairs when he lost balance and fell, landing on his operative foot. He noted a popping sensation on his left ankle. The patient was referred to our institution, where physical examination showed a palpable gap and a positive Thompson test. The patient was admitted for re-operation. The pre-operative AOFAS hindfoot score was 32% at the time of first consult, with an SF-36 mean score of 30.8%.

Surgical technique

Open Achilles tendon repair was done in the operating room. Patients were under spinal anesthesia and placed in a prone position with a bolster on the anterior distal leg to position the ankle in neutral. The repair technique is illustrated in Figure 3.

Skin surgical markings were placed outlining the Achilles tendon, the rupture site, and planned incision site on the posteromedial aspect of the ankle (Figure 4A). Upon incision and surgical exposure, the completely transected Achilles tendon was visualized. Tendon debridement was done, making sure that no fibrous tissue was interposed during suture repair of the tendon ends.

The modified Bunnell technique was performed using a size 1 knotless, unidirectional, absorbable barbed PDS suture to anastomose and repair the ruptured Achilles tendon ends. The starting point was made from the proximal tendon end, traversing the rupture and engaging on the distal tendon end (Figure 4B). A modified Bunnell stitch was done, crossing five times on each tendon end, with a total of ten per round. A total of three rounds with six suture cores were achieved prior to completing the repair with two throws traversing the rupture site (Figure 3), finally ending the repair by cutting the suture near the surface of the Achilles tendon (Figure 4C).

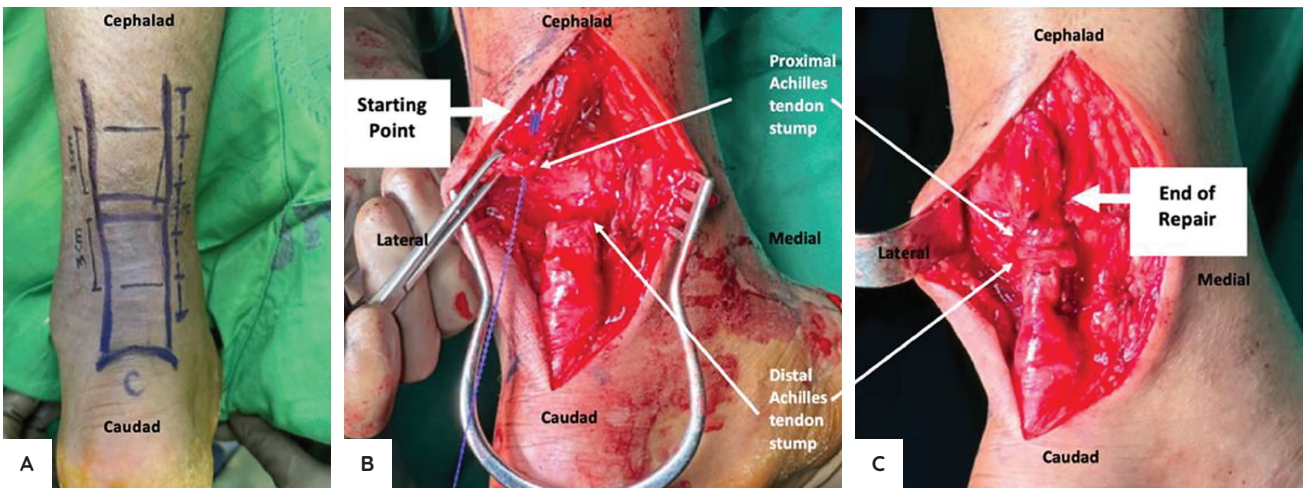


Figure 4. Skin markings **(A)**, starting point of suture repair **(B)**, and end of repair **(C)** for Case 1 (posterior view).

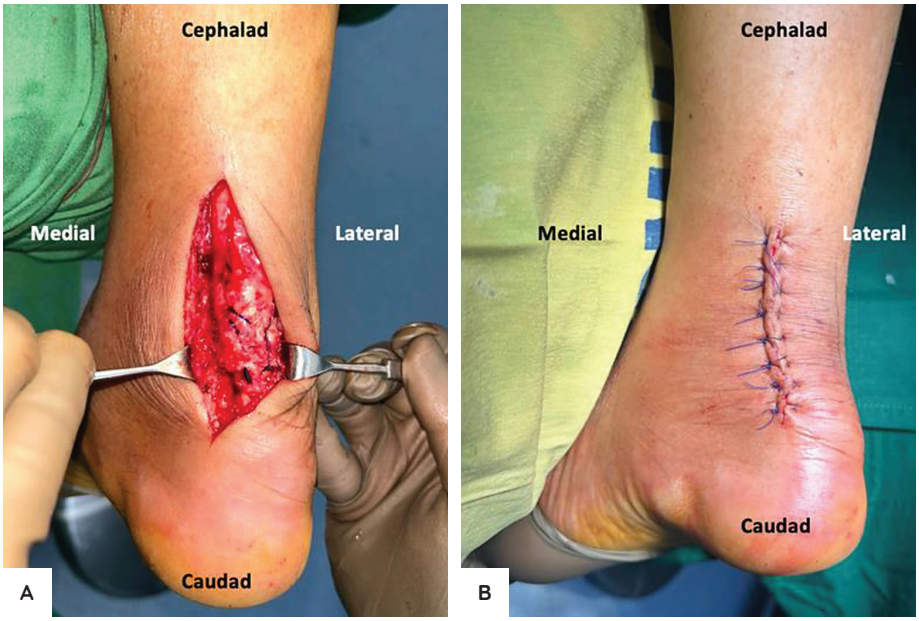


Figure 5. Intra-operative gross appearance after open repair **(A)** and closure **(B)** for Case 4 (posterior view).

Table 4. AOFAS Mean Score pre-operatively, 4 weeks post-operatively, and 6 months post-operatively

	Pre-operative	4 weeks post-operative	6 months post-operative
Case 1	34%	57%	100%
Case 2	13%	56%	95%
Case 3	37%	48%	91%
Case 4	41%	53%	86%
Case 5	32%	63%	96%
Mean	31.4%	55.4%	93.6%

Table 5. SF-36 Mean Score pre-operatively, 4 weeks post-operatively, and 6 months post-operatively

	Pre-operative	4 weeks post-operative	6 months post-operative
Case 1	55%	72%	90%
Case 2	27.8%	51%	78.5%
Case 3	40.3%	74.7%	83.3%
Case 4	46%	69%	86.6%
Case 5	30.8%	66.7%	89.7%
Mean	40%	66.7%	85.6%

Postoperative Thompson tests were negative (presence of ankle plantarflexion with calf compression). Closure was done (Figure 5), and the ankles were immobilized in an anterior blocking splint in gravity equinus. Patients were sent home with strict instructions on post-operative rehabilitation.

Post-operative rehabilitation

For each patient, an anterior blocking splint immobilized the ankle in gravity equinus for four weeks. The splint was converted into a more plantigrade position from the fourth to the sixth week post-operatively. Ambulation was not allowed for a total of six weeks. After six weeks, the ankle was placed in a plantigrade position in an Aircast and ambulation was allowed. Unrestricted ambulation without immobilization was achieved by eight weeks post-operatively.

RESULTS

This was a case series of five patients between 2023 and 2024 with a mean follow-up of six months. All patients presented with a chief complaint of ankle pain secondary to sports injury. Patients experienced immediate ankle pain, a popping sensation, and inability to ambulate while landing from a jump or due to an error in footwork during recreational sports (four basketball, one badminton). Consults were delayed between one and three weeks. All patients underwent open Achilles tendon repair and strict post-operative rehabilitation. The AOFAS hindfoot and SF-36 functional scores were documented at the fourth week and sixth month post-operatively. The assessment of the patients' gait, range of motion, ability to do squats, jumps, and calf raises was recorded at six months post-operatively.

American Orthopaedic Foot and Ankle Society (AOFAS) Hindfoot Score

The mean AOFAS hindfoot score was 31.4% pre-operatively, 55.4% at four weeks post-operatively, and 93.6% at six months post-operatively (Table 4). The mean difference in scores at six months post-operative was 62.

Short Form Health Survey (SF-36) Score

The mean SF-36 score was 40% pre-operatively, 66.7% at four weeks post-operatively, and 85.6% at six months post-operatively (Table 5). The mean difference in scores at six months post-operative was 46.

At the sixth month of follow-up, all five patients were ambulatory without assistance and were satisfied with their gait. All surgical sites healed uneventfully, with no signs of

infection or other subjective complaints. By this time, the suture had likely undergone complete absorption, thereby reducing the risk of long-term infection compared with non-absorbable sutures. Focused physical examination of the ankle showed negative Thompson and Matles tests, confirming that the Achilles tendon had healed. There was no limitation in ankle range of motion with dorsiflexion, plantarflexion, adduction, abduction, inversion, and eversion. All patients were able to do squats, jumps, and calf raises (Figures 6 and 7) without pain, apprehension, or ankle stiffness. Patients were able to resume their activities of daily living and were advised to follow up as needed for new complaints.

DISCUSSION

The Achilles tendon is the most common tendon to rupture despite being the strongest tendon in the body. Surgical repair remains the gold standard of management, involving direct anastomosis of ruptured tendon ends using non-absorbable sutures to provide support during the healing process. This has shown lower re-rupture rates compared to conservative treatment;[2] however, it has increased risk for complications such as infection, scarring, and sural nerve injury.[6]

The knotless, unidirectional, barbed suture is an absorbable suture device that eliminates the need for tying. Its fixating barbs maintain tension on each pass when compared with traditional sutures, eliminating weaker spots from slippage or higher-tension spots, which are prone to disruption.[7] This study was able to translate Kanz et al.'s biomechanical findings into a clinical setting at a tertiary hospital.[5]

Karasu et al. identified a minimum clinically important improvement of more than 38 points in the AOFAS score following Achilles tendon repair.[8] This threshold was exceeded by the 62-point improvement observed in this study. To our knowledge, no published study has reported the mean improvement in SF-36 scores after open Achilles tendon repair, regardless of suture used, against which to compare our mean difference of 46. Further investigation with larger populations and longer follow-up will help validate the results from this pilot study.

LIMITATIONS

The barbed suture had a tendency to coil on each pass, adding difficulty to the surgery. This is resolved by having the surgical assistant hold onto the remaining suture and prevent coiling. The surgical assistant must also make sure that the ends of the tendons are opposed properly with tension comparable to the contralateral ankle before traversing the tendon ends with the barbed suture. A mistake in the entry can be redone with the same suture, but may decrease the strength of the tendon or the strength of the repair. This procedure is fairly easy



Figure 6. Left ankle plantarflexion **(A)** and dorsiflexion **(B)** (lateral view), squatting, posterior view **(C)**, jumping, anterior view **(D)**, and calf raises, lateral view **(E)** at the 6-month follow-up for Case 1.



Figure 7. Squatting, lateral view **(A)**, jumping, posterior view **(B)**, and calf raises, lateral view **(C)** and posterior view **(D)** at the 6-month follow-up for Case 3.

to follow even for new surgeons unfamiliar with the suture technique, although practice can be beneficial.

The suture was 45 centimeters long, adequate to span and repair the ruptured Achilles tendon in all five Filipino patients. However, it is possible that more than one suture will be required to repair the Achilles tendon of larger patients, which may result in inconsistencies in the repair.

Although a non-absorbable barbed suture could have been a direct comparison, it is not readily available in our institution.

Ultrasound was not performed at the end of the study to check for suture resorption. We had no re-operations due to suture granuloma, which may be because the absorbable nature of the suture prevents granuloma formation. Other factors that could have contributed to the uneventful post-operative course were proper patient education, wound care, and rehabilitation.

Although the sample size was small, the findings provide valuable information and may encourage further investigation through larger-scale studies on this topic. Readers may use the current data at their own discretion and with appropriate consideration of the associated risks and limitations.

CONCLUSION

All five patients had unremarkable post-operative courses with return to activities of daily living on par with traditional repair. All patients were ambulatory with no complaints about their gait. They had good ankle range of motion and function with no difficulty doing jumps, squats, and calf raises by six months post-operatively. The AOFAS score showed a mean difference of 62 at six months post-operative, indicating improved foot and ankle function, reduced pain, and improved overall mobility. The SF-36 score showed a mean difference of 46, indicating better overall health-related quality of life, reflecting improvements in physical functioning, mental health, social functioning, and overall well-being.

In conclusion, the use of knotless, unidirectional, absorbable barbed suture is a novel and reproducible treatment option for closed Achilles tendon ruptures, providing good clinical and functional outcomes.

ETHICAL CONSIDERATIONS

Patients' consent was obtained before the submission of the manuscript.

STATEMENT OF AUTHORSHIP

All authors certified fulfilment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

GSBC: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – original draft preparation, Writing – review and editing, Visualization, Project administration; **ECT:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing – original draft preparation, Visualization, Supervision, Project administration; **DTDJ:** Methodology, Validation, Formal analysis, Resources, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed in this study are included in the published article.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

FUNDING SOURCE

None.

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