

Twinkle artefact in the ultrasound diagnosis of superficial epidermoid cysts

Richard Clarke¹, Priya Suresh², Rose Thomas³ and Simon Freeman²

Abstract

Aim: The aim of the study was to evaluate whether the twinkle artefact is a valuable feature in the sonographic diagnosis of superficial epidermoid cysts.

Materials and methods: A retrospective search was undertaken of our institution's Radiology Information System and pathology database to identify cases of superficial masses showing the twinkle artefact that proceeded to surgical excision.

Results: Eighteen superficial masses demonstrating the twinkle artefact were identified that were submitted for pathological analysis. Of these, 17 were confirmed to represent epidermoid cysts and only 1 case had an alternative diagnosis (proliferating trichilemmal cyst).

Conclusion: The presence of the twinkle artefact appears to be a specific and valuable ancillary sonographic feature for the diagnosis of superficial epidermoid cysts.

Keywords

Twinkle artefact, epidermoid cyst, sebaceous cyst, colour Doppler ultrasound

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Introduction

The twinkle artefact (TA) is a colour Doppler artefact that describes rapidly fluctuating artefactual colour pixels behind strongly reflective static interfaces, particularly calcified lesions, which may simulate high velocity and disturbed blood flow.^{1,2} The artefact is well known to most ultrasound practitioners and can be employed as a valuable additional sonographic feature in detection of renal calculi, particularly in situations where the use of ionising radiation is undesirable.³ This artefact has also been described in a number of other abdominal and pelvic conditions.⁴

Colour and power Doppler are routinely used in the sonographic assessment of superficial masses to identify the presence of blood flow and are a valuable addition to grey scale ultrasound in differentiating solid from complex cystic lesions and also in assessing whether a mass has features of concern for malignancy.

Superficial visible or palpable masses are a common reason for patients to seek medical advice and

ultrasound is now routinely requested in assessing these lesions. In addition to defining the position, borders and relationship to adjacent structures, ultrasound can assess for the presence of internal vascularity. Epidermoid cysts (often incorrectly referred to as sebaceous cysts) represent one of the most common superficial masses and will be regularly encountered by most ultrasound practitioners. Ultrasound has good accuracy in characterising epidermoid cysts based on their grey scale and Doppler appearances but there is a wide

¹Peninsula Radiology Academy, Plymouth UK

²Imaging Department, Derriford Hospital, Plymouth UK

³Department of Radiology, The Austin Hospital, Melbourne, Australia

Corresponding author:

Simon Freeman, Derriford Hospital, X-Ray West, Level 6, Plymouth PL6 8DH, UK.

Email: simonfreeman@nhs.net

variety in their echogenicity, from cystic to 'pseudo solid', which may cause diagnostic uncertainty.^{5,6}

Two of the authors of this study had independently observed the TA in patients with superficial skin lesions that had clinical and greyscale ultrasound features of epidermoid cysts in their routine clinical practice. No association between TA and epidermoid cysts was identified in a literature search and therefore a retrospective study was undertaken with the purpose of determining whether the TA was a specific sonographic feature of epidermoid cysts.

Materials and methods

A word search of radiology reports on the hospital Radiology Information System (RIS) for the key words 'epidermoid, twinkle and sebaceous cyst' was undertaken covering all ultrasound studies between the dates 1 January 2012 and 31 March 2015. The search returned 821 reports which were then reviewed to identify cases of superficial lesions showing the TA; this resulted in 60 matches. These cases were cross-referenced with the hospital pathology database showing that 17 lesions had been excised and subjected to pathological analysis. The other 43 cases did not have pathology data and were eliminated from further analysis.

A further interrogation of the pathology database between the dates 1 Jan 2012 and 31 March 2015 using the key word 'cyst' identified 449 patients. Review of these cases revealed 253 cases of histologically proven epidermoid cysts. These cases were then cross-referenced with the RIS system and the reports and images were reviewed; this identified one additional patient not found in the initial radiology search with a superficial lesion showing the TA on a colour Doppler soft copy image where the key words had not been used in the subsequent report.

The study sample therefore consisted of 18 patients with superficial skin lesions demonstrating the TA with subsequent pathological analysis. The methodology is summarised in Figure 1.

In one patient, with a clinical and sonographic diagnosis of an epidermoid cyst, we examined the excised surgical specimen sonographically in a water bath immediately after excision and before pathological analysis to determine whether the TA could be reproduced *in vitro*.

All ultrasound examinations were performed on Toshiba Aplio ultrasound platforms (Toshiba Medical Systems Corporation, Tochigi-ken, Japan) with a variety of high-frequency broadband linear array transducers using small parts and musculoskeletal specific manufacturer presets. There was a variety of levels of experience of the ultrasound practitioners undertaking

the examinations, but the majority (15) were performed by consultant radiologists (sub-specialist interests: musculoskeletal radiology (4), ultrasound (10), and cross-sectional imaging (1)). The other scans were performed by a consultant sonographer (2) and experienced radiology SpR (1).

Institutional Review Board approval (and waiver of ethical approval) was granted for this retrospective study. The excised lesion that was studied *in vitro* was examined with written consent having been obtained from the patient concerned.

Results

The study consists of 18 patients with superficial lesions demonstrating the TA and with subsequent pathological analysis (see Figures 2 and 3). The 18 superficial masses included in the final analysis were located in the cranio-facial soft tissues (7), neck (6), axilla (2), anterior abdominal wall (1), ankle (1), and inguinal region (1); 17 of the 18 patients (94.4%) had a final histological diagnosis of epidermoid cyst. In only one case (5.6%) was there a different final diagnosis of a proliferating trichilemmal cyst.

In one case, the excised lesion (subsequently histologically confirmed to be an epidermoid cyst) was scanned in a water bath within one hour of surgical excision. Ultrasound confirmed extensive TA in this specimen (Figure 4).

Discussion

TA is a poorly understood colour Doppler ultrasound artefact characterised by rapidly fluctuating colour Doppler pixels (Figures 2 to 4) and a similar artefact can also be seen with power Doppler applications (Figure 4(c)). TA is commonly seen behind highly reflective interfaces and is often associated with calcified lesions. Spectral Doppler analysis obtained from within the artefact typically shows closely aligned vertical bands without a discernible vascular waveform (Figure 4(d)),⁷ helping to confirm the artefactual nature of the colour signal. Strong TA signal is not usually significantly affected by the colour velocity scale (pulse repetition frequency),⁷ also confirming its artefactual nature (Figures 2 and 4). TA is influenced by other machine settings, particularly the focus (Figure 3) with the artefact occurring above the level of the focal zone. This characteristic can also be used to distinguish this artefact from true blood flow. Other machine settings including colour write priority, grey scale gain, and acoustic power⁴ may also affect the intensity of the artefact.

The cause of the TA is uncertain. One hypothesis suggests that it is due to the ultrasound beam impinging

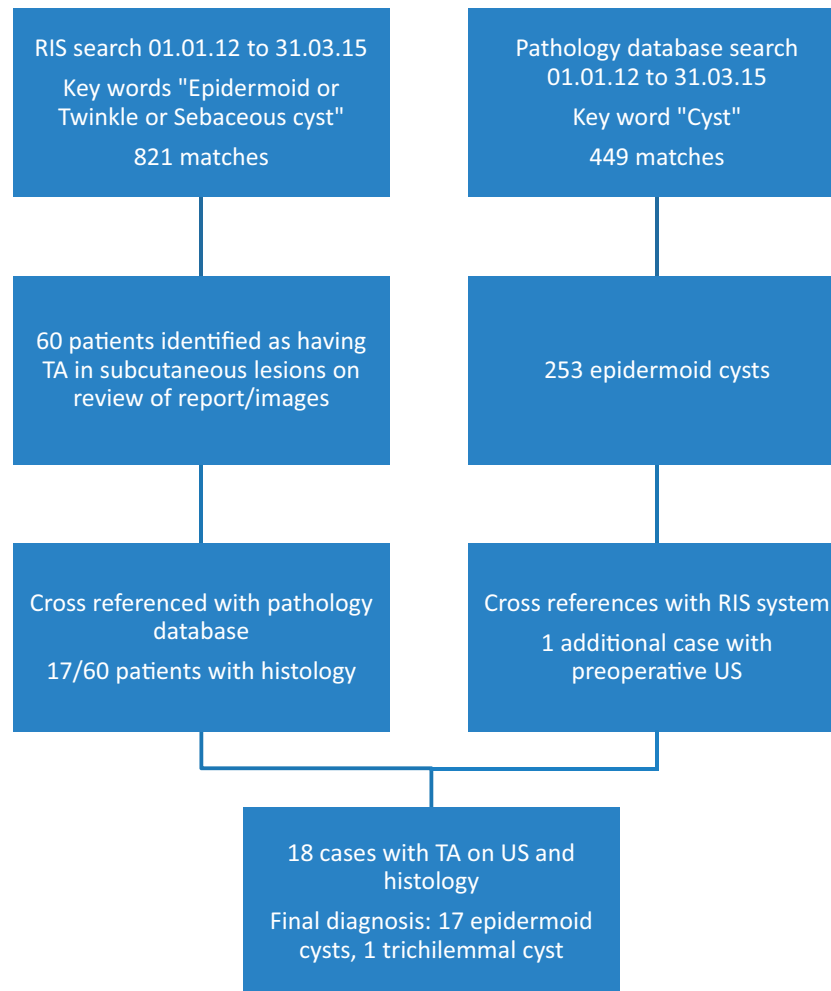


Figure 1. Summary of the study methodology.

on a strongly reflecting surface with a rough interface, producing multiple complex reflections resulting in an increased pulse duration of the received ultrasound echo, interpreted as movement, and assigned colour pixels by the Doppler processing software within the ultrasound system.² An alternative explanation is that the artefact is primarily dependent on narrow bandwidth noise introduced by phase (clock) jitter within the Doppler processing components of the ultrasound system, with roughness of the reflecting interface as a secondary cause.⁸ Other researchers believe that the twinkling artefact associated with renal calculi may be caused by tiny movements of the stones caused by the sound beam itself; this causes uncertainty as to the signal origin which is amplified by complex processing algorithms forming an image with TA.⁹ There is also evidence to suggest that the TA seen with renal calculi is caused by small gas bubbles trapped within imperfections on the stone surface.¹⁰

Regardless of its cause, the TA can be harnessed as a valuable artefact by ultrasound practitioners, particularly in the context of renal stone identification, but also in a variety of abdominal and pelvic pathologies including parenchymal calcifications, gallbladder adenomyomatosis, bile duct hamartomas, choledocholithiasis, and foreign body identification.⁴

Ultrasound has become a valuable and increasingly requested, imaging investigation to evaluate patients presenting with palpable superficial masses. It can determine whether the mass is solid, cystic, or mixed in consistency, evaluate the margins, define the relationship to adjacent structures, accurately measure size, and confirm that the mass is confined to the superficial skin layers. These features can help to categorise many masses as likely benign or more sinister in appearance and provide valuable information for patient management.^{5,11–13} Colour and power Doppler are routinely employed in the sonographic assessment of superficial masses to assess lesion

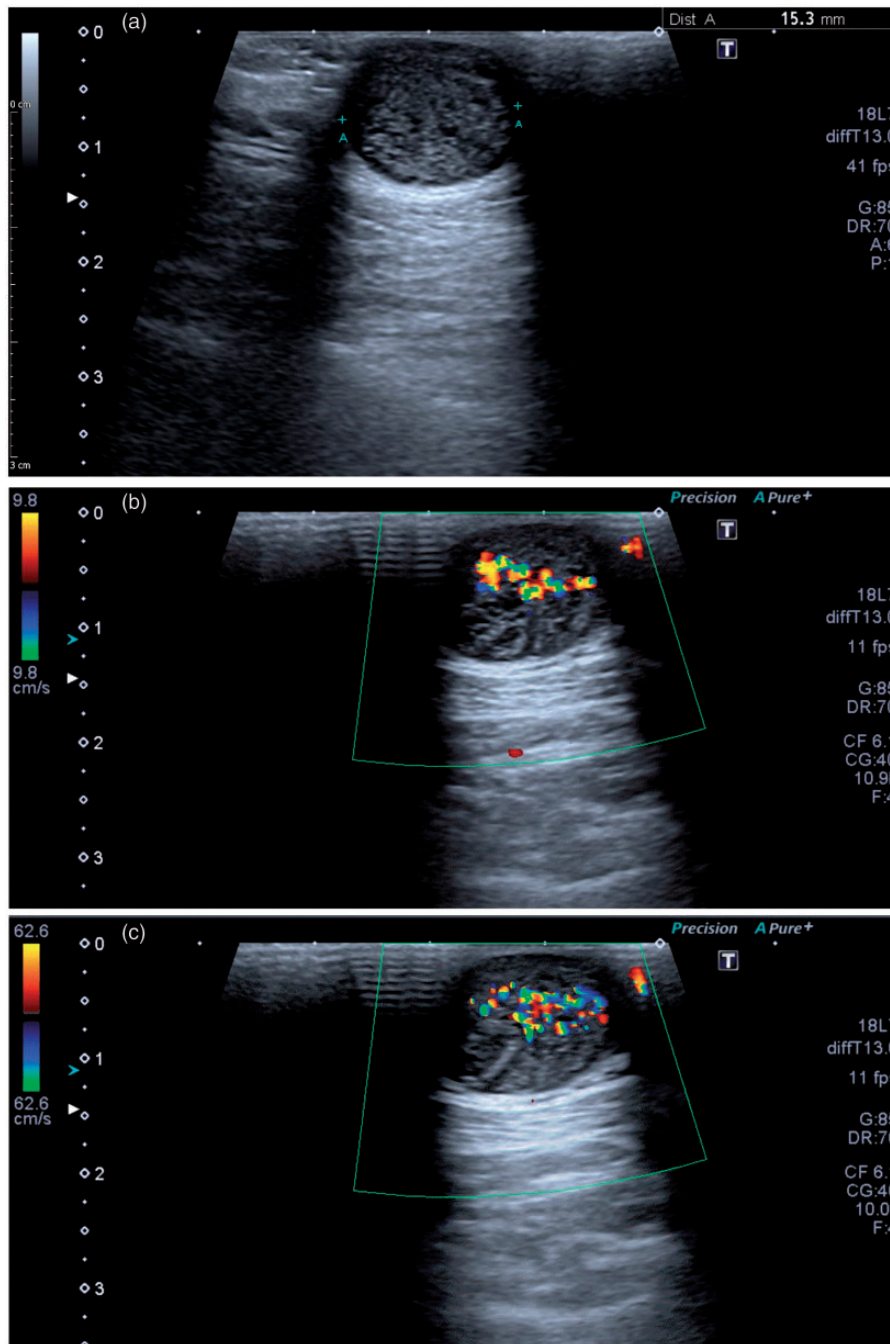


Figure 2. Female patient referred for ultrasound with palpable mass in the posterior aspect of the neck. (a) Grey scale ultrasound demonstrates a spherical subcutaneous mass of mixed echogenicity with posterior acoustic enhancement. (b and c) The twinkling artefact is present on both low (9.8 cm/s) and high velocity (62.6 cm/s) flow settings showing that the artefact is independent of the velocity scale (pulse repetition frequency). Following surgical excision, histology confirmed an epidermoid cyst.

vascularity and help to further characterise and define lesions as likely benign or potentially malignant.¹⁴ The addition of ultrasound has been shown to increase diagnostic accuracy for subcutaneous lesions over clinical palpation alone.¹⁵ In certain cases, ultrasound can also be used to guide percutaneous tissue biopsy.

Skin cysts are a common reason for patients to seek medical attention and represent one of the most frequently excised surgical specimens. Such cysts are frequently referred to as 'sebaceous cyst' but this is a misleading term as most of these cysts do not arise from sebaceous glands and are either epidermoid

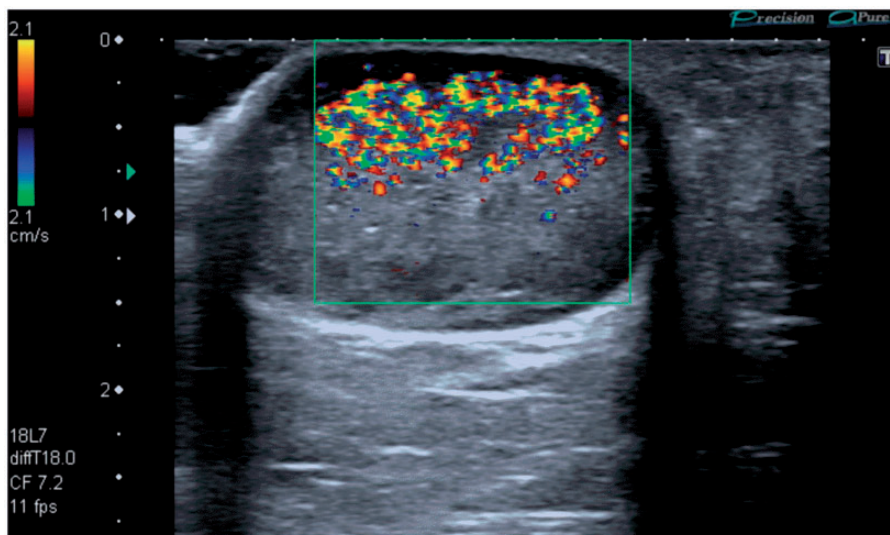


Figure 3. A 49-year-old patient presenting for ultrasound examination of a palpable mass in the axilla. Note that TA is only seen at and above the focal zone.

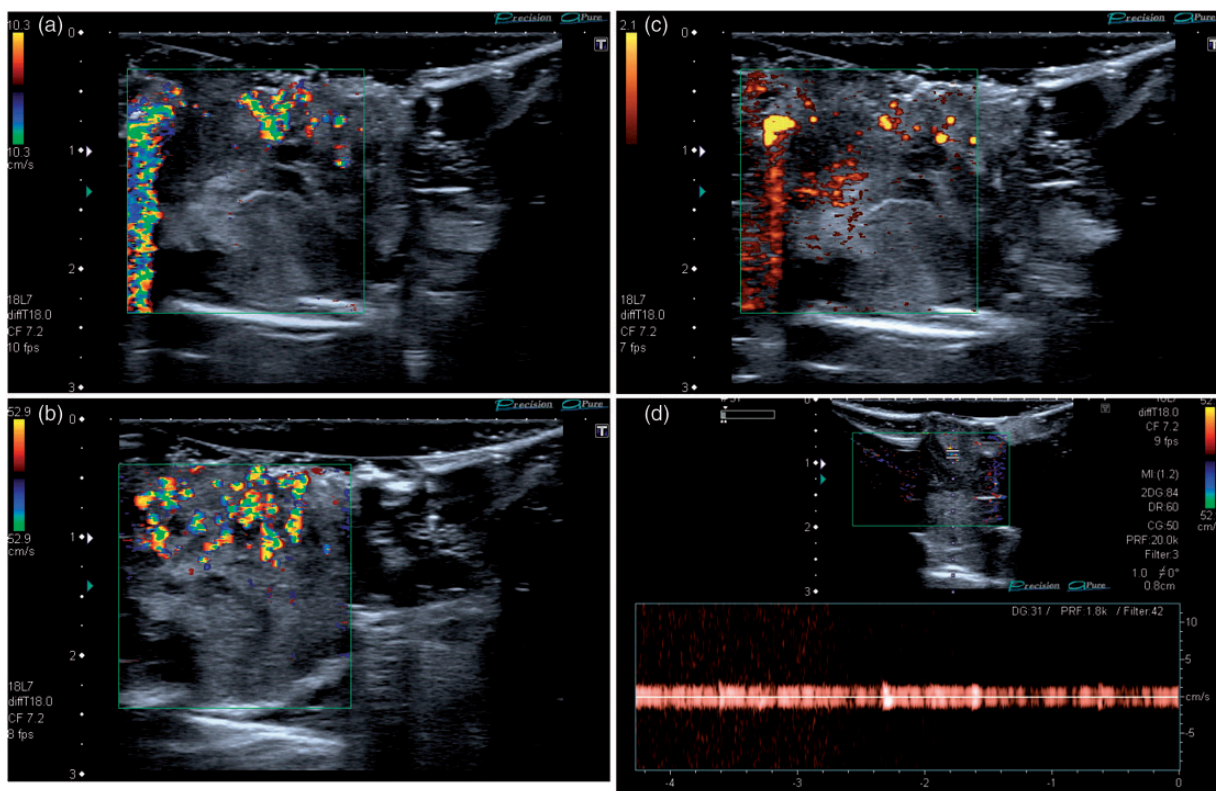


Figure 4. Images of an excised epidermoid cyst scanned in a water bath. (a and b) The TA artefact is present and again seen to be independent of the velocity scale. (c) Colour artefact is also seen with power Doppler imaging. (d) Spectral Doppler analysis shows artefactual vertical bands without a discernible vascular waveform above background machine noise to the reader’s left of the spectral trace, abolished by reduction of Doppler gain to the right of the trace.

(inclusion) cysts or pilar (trichilemmal) cysts; true sebaceous cysts (containing sebum) are uncommon. Epidermoid cysts occur most frequently on the face, neck, and upper trunk and originate in the epidermis; they are thought to arise from the infundibulum or uppermost portion of the hair follicle and have a true epithelial lining. Pilar cysts are most commonly found on the scalp and originate from hair follicles. Both types of cyst contain keratin and they can only be differentiated by pathological examination following surgical excision.¹⁶ Surgical treatment for epidermoid and pilar cysts is not usually required unless the cyst becomes infected, interferes with everyday life, or is cosmetically unsightly. Treatment involves complete surgical excision to minimise the risk of recurrence. Biopsy should be avoided to prevent cyst rupture.¹⁶

Epidermoid cysts may have a variety of sonographic appearances. Typically, they are confined to the skin layers but may expand into the subcutaneous fat,¹⁷ have well-defined margins, and measure less than 5 cm in size. Usually, they demonstrate posterior acoustic enhancement, indicating their cystic nature (Figure 2(a)). They may vary from almost anechoic to echogenic, the more echogenic types having a 'pseudo solid' appearance.¹⁸ Frequently, the cyst will show an oval shape with homogeneous low to medium echogenicity simulating testicular parenchyma, an appearance that has been named the 'pseudotestis sign'.⁶ Dermal attachment or dermal protrusion have also been described as features that help differentiate epidermal cysts from other superficial soft tissue masses.^{6,19} Epidermoid cysts do not demonstrate associated vascularity on colour Doppler examination unless they have ruptured, resulting in development of granulation tissue.²⁰ Although the specificity of ultrasound in diagnosis of epidermoid cysts is high,¹⁵ they may be mistaken for other masses, particularly when showing the pseudo solid appearance.

In this retrospective study, we found the TA to be a highly specific feature of epidermoid cysts, being seen in 17 of the 18 superficial lesions where the TA was identified in the report or subsequent image review. In the one case with an alternative final histological diagnosis, the mass proved to be a trichilemmal (pilar) cyst, which is a closely related mass, and differentiation between these two entities is of no significance for patient management. No other types of superficial mass demonstrating the TA proceeded to excision and histology in this study. The artefactual nature of the colour Doppler TA was confirmed by scanning an excised epidermoid cyst in a water bath where the TA was strongly present (Figure 4). We suspect that the TA is explained by the strong reflecting interfaces arising from keratin layers in the epidermoid cyst, although further *in vitro* studies would be necessary to confirm

this hypothesis. The location of the majority of the epidermoid cysts in this series was either in the craniofacial soft tissues or the neck; this is a typical location for these lesions which are most commonly found on the face, neck, or upper body (chest and shoulders).¹⁵

This study has a number of significant limitations. The retrospective nature of data collection may have failed to identify cases where TA was present but not described in the radiological report and cases where colour Doppler analysis was not performed by the ultrasound operator. The study also assumes that all ultrasound practitioners in our institution are familiar with the TA and recognised it as an artefact rather than true vascular flow; we are unable to confirm that this is the case. Due to the retrospective methodology, it was not possible to standardise the machine settings, presets and transducers, all of which may have influenced TA. Finally, it is clear that in the majority of cases with a superficial mass showing TA, patients did not proceed to surgical excision and pathological analysis and that most of the surgically excised epidermoid cysts did not undergo preoperative ultrasound. Despite these limitations, this study suggests that the TA may be a specific feature of superficial epidermoid cysts and can be used as a valuable additional sonographic finding to differentiate epidermoid cysts from other superficial skin lesions. Further prospective studies would be desirable to confirm this preliminary observation and to establish the value of TA in the diagnosis of epidermoid cysts.

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Ethical approval

The study was granted waiver of ethical approval by the institution's Ethics and Research Committee. Written permission was obtained from the patient for the *ex-vivo* ultrasound study and use of images for the excised lesion reproduced in Figure 4.

Guarantor

SF.

Contributorship

SF and PS created the study concept and design. RC and RT collected the data and wrote the first manuscript draft. SF prepared the final manuscript which was edited and approved by all authors.

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