Original Article

Comparison of magnetic resonance elastography and transient elastography in the diagnosis of hepatic fibrosis: a systematic review and meta-analysis

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Background: Few studies comprehensively compared the performance of magnetic resonance elastography (MRE) and transient elastography (TE) in the diagnosis of liver fibrosis. Therefore, we conducted a meta-analysis to evaluate and compare the diagnostic efficacy of these 2 techniques in patients with hepatic fibrosis in order to gain a better understanding of their overall diagnostic performance and aid in maximizing their clinical utility.

Methods: Systematic literature searches of the PubMed, EmBase, Cocharane Library, and China National Knowledge Infrastructure databases were carried out to identify studies that applied MRE and TE in the diagnosis of liver fibrosis. The combined sensitivity, specificity, positive and negative likelihood ratios, and diagnostic odds ratio (ORs) were estimated using a bivariate random effects model. Review Manager 5.2 was used to analyze the selected articles, and forest plot, sensitivity, and bias analyses were performed for the included literature. To determine the diagnostic efficacy of MRE and TE for liver fibrosis, pooled sensitivity and specificity analyses were conducted.

Results: Eight studies met the inclusion criteria. In the diagnosis of stage F0–F1 liver fibrosis, MRE showed higher sensitivity than TE (OR =0.62, 95% CI: 0.41–0.95, P=0.03). MRE also showed higher specificity than TE for diagnosing stage F2–F4 liver fibrosis (OR =0.41, 95% CI: 0.27–0.62, P<0.0001). There was no difference in the sensitivity of MRE and Te to F2–F4 hepatic fibrosis and the specificity of MRE and Te to F0–F1 hepatic fibrosis.

Conclusions: In terms of sensitivity and specificity, MRE is superior to TE in diagnosing different stages of liver fibrosis to a certain extent. MRE may be a useful, noninvasive method for the assessment of liver fibrosis in patients with chronic liver disease.

Keywords: Magnetic resonance elastography (MRE); transient elastography (TE); hepatic fibrosis; liver fibrosis; meta-analysis

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Introduction

Liver fibrosis occurs when liver cells regenerate after repeated damage and there is an increase in the diffuse deposition and abnormal distribution of extracellular matrix proteins such as collagens, glycoproteins, and proteoglycans in the liver (1,2). Liver fibrosis is a key step in the pathological repair of chronic liver injury and an important link in the development of various chronic liver diseases to cirrhosis. Moreover, it is a factor influencing the prognosis of patients with chronic liver diseases (3-5).

Transient elastography (TE) technology consists of 3 key parts: a transducer that generates ultrasonic waves and acts as an ultrasonic receiver; a probe on the transducer that emits low-frequency vibration waves; and a software program for data recording and analysis (6-8). TE is widely used in the assessment of various organs in the body. Instantaneous elastography technology has the advantages of being non-invasive, painless, fast, and convenient for bedside and outpatient examinations; further, the results have good repeatability. Instantaneous elastography technology can not only be used to non-invasively diagnose liver fibrosis but also to monitor the development of liver disease and evaluate the effect of anti-fibrosis therapy (9-11).

Magnetic resonance elastography (MRE) is a non-invasive and quantitative imaging method for examining soft tissue elasticity and structure. MRE is the longest established and most widely used imaging method in the diagnosis and classification of liver fibrosis (12,13). In the progression of liver fibrosis, liver stiffness increases significantly due to the aggregation of collagen fibers. The elasticity value obtained by MRE can distinguish liver fibrosis (F1–F3) and liver cirrhosis with good sensitivity and specificity. Owing to its non-invasive characteristics compared to traditional liver biopsy, MRE has been used for clinical testing and diagnosis in hepatic fibrosis (14,15).

Since there are few reports comparing MRE and TE in the diagnosis of liver fibrosis, this meta-analysis was conducted to gain a better understanding of the overall diagnostic performance of these 2 techniques in hepatic fibrosis and to help maximize their clinical utility. We present the following article in accordance with the PRISMA reporting checklist (available at https://dx.doi.org/10.21037/apm-21-1176).

Methods

Literature search strategy

Systematic literature searches were carried out to identify studies comparing the diagnostic performance of MRE and ultrasonic TE in hepatic fibrosis that were published between 2007 and 2020. Databases including PubMed, EMBASE, the Cochrane Library, and China National Knowledge were searched using the following keywords: (I) MRE; (II) TE; (III) hepatic fibrosis. All of these words were assembled with the Boolean operator "and". In order to maximize the specificity and sensitivity of each search, the researcher also checked the reference lists of retrieved studies to identify other potential studies of relevance that were not included in the initial search results.

Study selection criteria

The inclusion criteria for this meta-analysis were: (I) studies comparing MRE with TE for the diagnosis of hepatic fibrosis; (II) studies reporting the diagnostic sensitivity and specificity of the 2 imaging methods; and (III) studies comparing the parameters for each fibrosis stage.

The exclusion criteria were: (I) studies that did not compare the sensitivity and specificity of MRE and TE; (II) study participants had diseases other than liver fibrosis; (III) they are duplicate data; (IV) limited or insufficient research data.

Data extraction and quality assessment

The full texts of the manuscripts (16-23) were read independently by 2 reviewers, and any discrepancies were resolved through discussion with another author. The following data were extracted from each eligible study: first author's name, country of origin, publication year, sample size, study time, and age and sex of the study participants.

Statistical analysis

Review Manager 5.2 was employed to estimate the effects of selected articles. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for continuous results. Heterogeneity across studies was assessed using the Q statistic and the I^2 statistic, which is a quantitative measure of inconsistency among studies. Studies with an I^2 statistic of >75% were considered to possess a high degree of heterogeneity; studies with an I^2 statistic of 50–75% were considered to possess a moderate degree of heterogeneity; and studies with an I^2 statistic of 25–50% were considered to possess a low degree of heterogeneity. If I^2>50%, potential sources of heterogeneity were identified through sensitivity analyses conducted by omitting 1 study at a time and investigating the effect on the overall pooled estimate. If heterogeneity was not significant, the Mantel-Haenszel fixed-effects model was applied to compare ORs and 95% CIs; otherwise, a random-effects model was used.

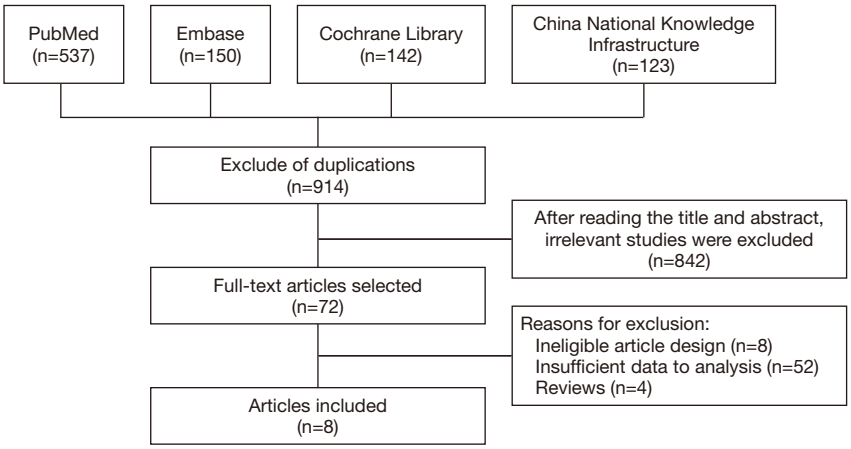

Figure 1 Flow diagram of the study selection.

Table 1 Characteristics of the studies included in the meta-analysis

Study	Year	Language	Country	No. of participants (female/male)	Age range (mean)	n	Years of onset
Bohte	2013	English	Netherlands	30/55	55±9.5	85	November 2009 to March 2012
Chen	2017	English	China	133/74	48.6±6.5	207	March 2010 to May 2013
Forsgren	2020	English	Sweden	41/49	52.5±13.2	90	May 2007 to May 2014
Fu	2019	English	China	36/64	37.6±9.3	100	May 2014 to January 2017
Furlan	2020	English	USA	36/26	50±13	62	October 2015 to December 2017
Lefebvre	2019	English	Canada	47/53	55±12	100	July 2014 to January 2018
Tafur	2020	English	Canada	34/53	37.5±12.5	87	January 2014 to July 2016
Toguchi	2017	English	Japan	58/58	59.9±14.3	116	October 2013 to January 2015

Results

Search process

A total of 914 articles were retrieved in the electronic database search. After careful reading of their titles and abstracts, 72 articles were considered as being potentially relevant. After reviewing the articles against the eligibility criteria, we excluded 64 articles due to the article type, or having an ineligible research design or insufficient data. Finally, 8 eligible articles were included in this meta-analysis. The flow chart in *Figure 1* details the process of identifying eligible studies as well as the reasons for the inclusion and exclusion of studies.

Characteristics of the included studies

Table 1 summarizes the characteristics of the included studies. The 8 studies included in the meta-analysis involved a total of 847 participants (432 men and 415 women), with the study sample sizes ranging between 62 and 207 (16-23).

Results of quality assessment

The Cochrane risk of bias assessment tool was used to assess the included studies (*Figures 2* and *3*). Overall bias was not found in any article. In view of the bias assessment, no selection bias, performance bias, or reporting bias was

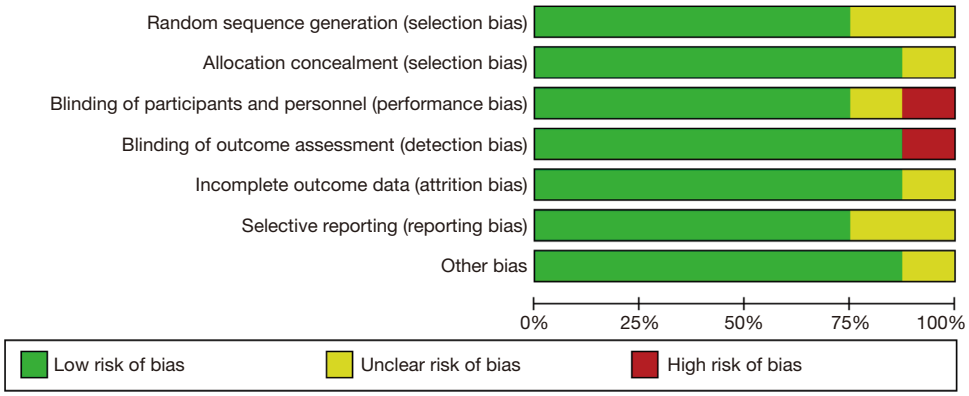

Figure 2 Assessment of the quality of the included studies (green hexagons indicate a low risk of bias, yellow hexagons indicate an unclear risk of bias, and red hexagons indicate a high risk of bias).

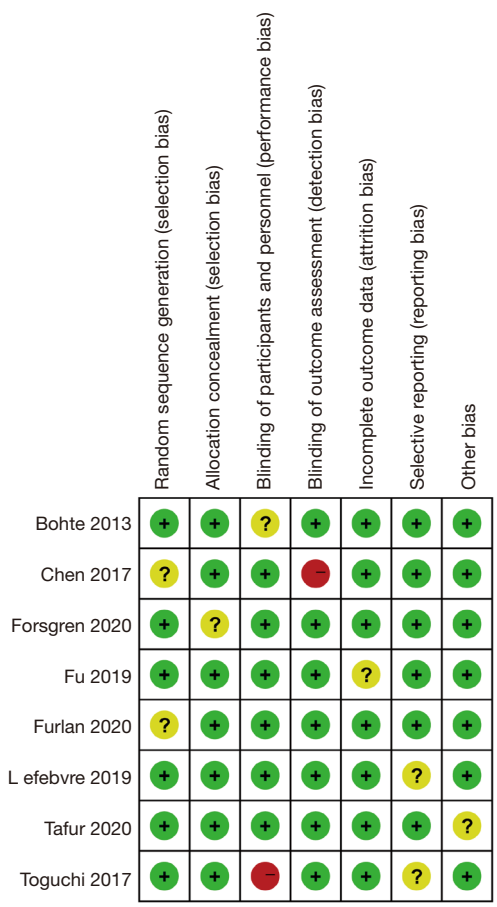

Figure 3 Quality assessment of the included studies.

found, and only 1 study showed detection bias and 1 study showed attrition bias. None of the included studies showed a high risk of bias (8).

Results of heterogeneity testing

Meta-analysis of the diagnostic sensitivity of MRE and TE in stage F0–F1 liver fibrosis

As shown in *Figure 4*, all 8 studies included diagnostic sensitivity of MRE and TE in stage F0–F1 liver fibrosis. The results showed that the sensitivity of MRE was higher than that of TE for the diagnosis of stage F0–F1 liver fibrosis (OR =0.62, 95% CI: 0.41–0.95, P=0.03; I^2=0%).

Meta-analysis of the diagnostic sensitivity of MRE and TE in stage F2–F4 liver fibrosis

As shown in *Figure 5*, all 8 studies included diagnostic sensitivity of MRE and TE in stage F2–F4 liver fibrosis. No difference in sensitivity was observed between MRE and TE in the diagnosis of stage F2–F4 liver fibrosis (OR =0.75, 95% CI: 0.49–1.15, P=0.19; I^2=0%).

Meta-analysis of the diagnostic specificity of MRE and TE in stage F0–F1 liver fibrosis

As shown in *Figure 6*, all 8 studies included diagnostic specificity of MRE and TE in stage F0–F1 liver fibrosis. No difference was found in specificity between MRE and TE in the diagnosis of stage F0–F1 liver fibrosis (OR =0.93, 95%

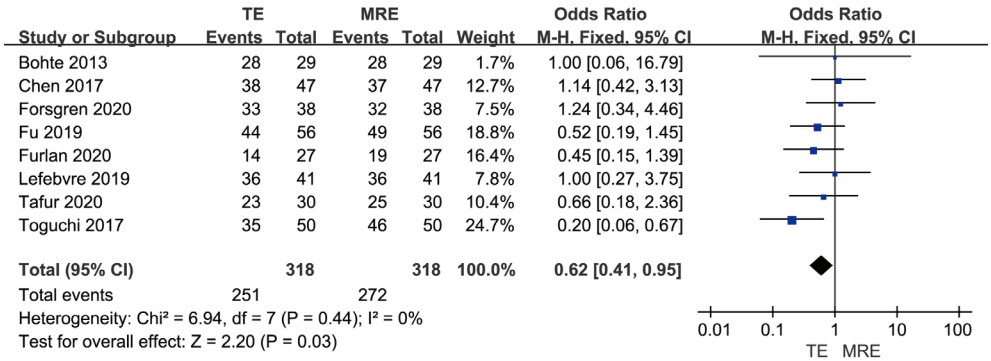

Figure 4 Forest plot of the sensitivity of TE and MRE in the diagnosis of stage F0–F1 liver fibrosis. TE, transient elastography; MRE, magnetic resonance elastography.

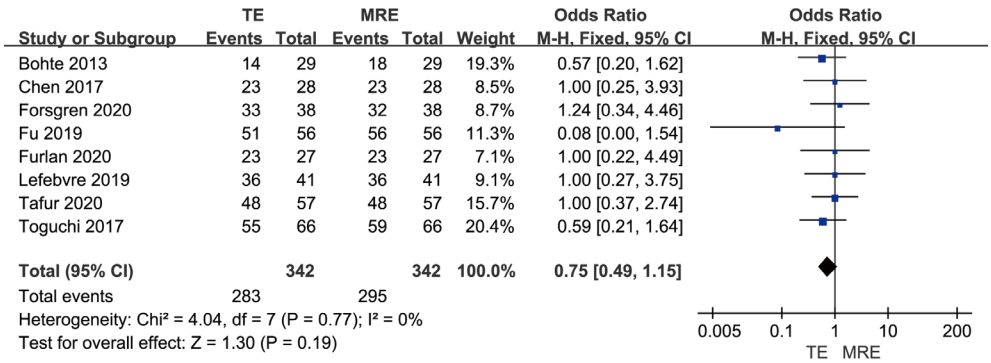

Figure 5 Forest plot of the sensitivity of TE and MRE in the diagnosis of stage F2–F4 liver fibrosis. TE, transient elastography; MRE, magnetic resonance elastography.

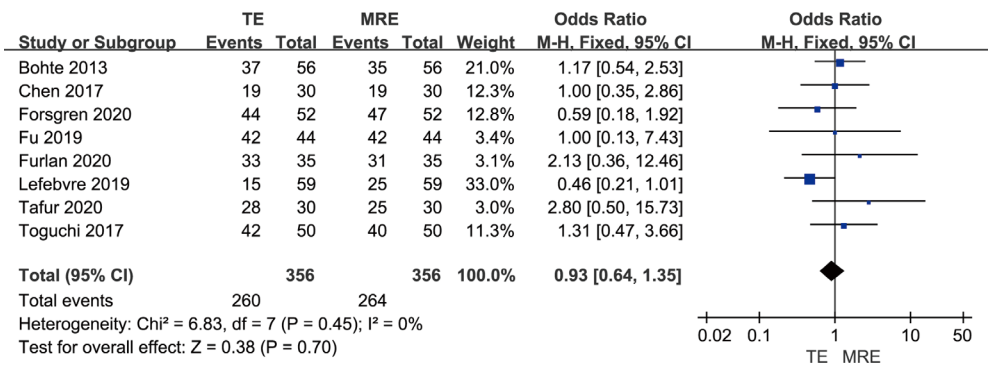

Figure 6 Forest plot of the specificity of TE and MRE in the diagnosis of stage F0–F1 liver fibrosis. TE, transient elastography; MRE, magnetic resonance elastography.

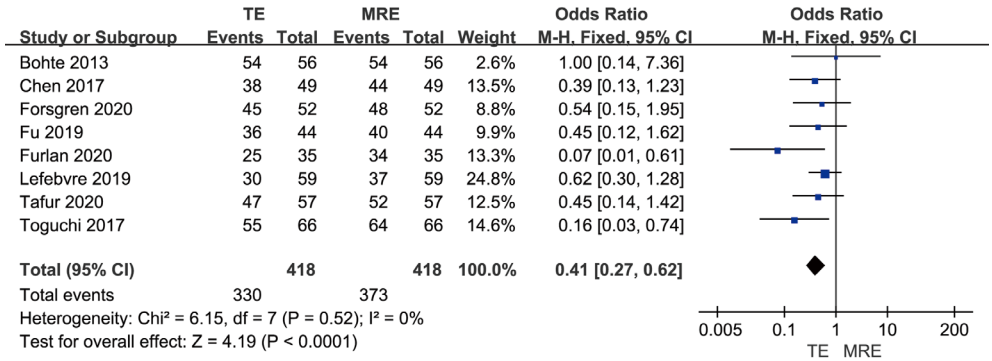

Figure 7 Forest plot of the specificity of TE and MRE in the diagnosis of stage F2–F4 liver fibrosis. TE, transient elastography; MRE, magnetic resonance elastography.

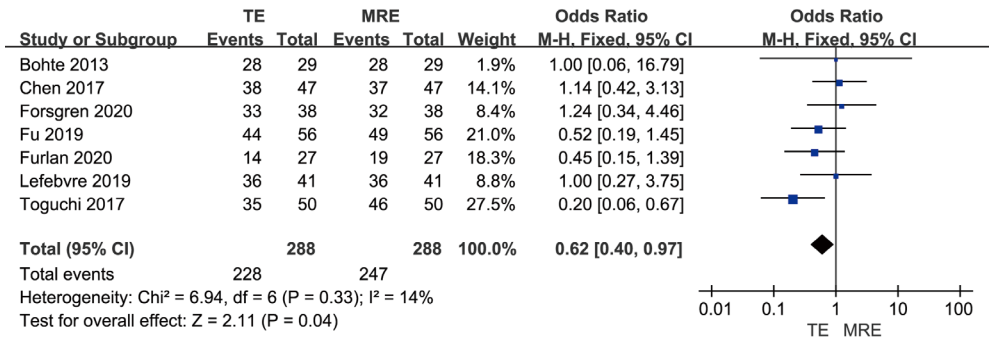

Figure 8 Sensitivity analysis forest plots.

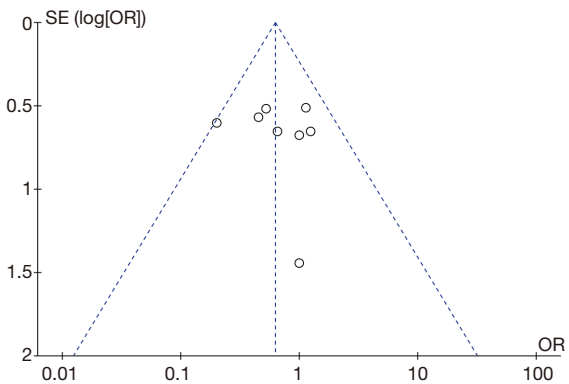

Figure 9 Funnel plot of publication bias.

CI: 0.64–1.35, P=0.70; I^2=0%).

Meta-analysis of the diagnostic specificity of MRE and TE in stage F2–F4 liver fibrosis

As shown in *Figure* 7, all 8 studies included diagnostic specificity of MRE and TE in stage F2–F4 liver fibrosis. The results showed that the specificity of MRE was higher than that of TE for the diagnosis of stage F2–F4 liver fibrosis (OR =0.41, 95% CI: 0.27–0.62, P<0.0001; I^2=0%).

Results of sensitivity and publication bias analyses

The results of the meta-analysis showed that MRE had higher sensitivity than TE for the diagnosis of hepatic fibrosis. As shown in the *Figure 8* the heterogeneity may be attributed to the differences in the results of the studies. After the exclusion of Tafur's 2020 study, I^2 changed from 0% to 14%, and the P value changed from 0.03 to 0.04 (*Figure 8*), indicating the reliability of the results of this article.

A funnel plot was drawn to assess publication bias in the 8 studies included in this meta-analysis (*Figure 9*). The good symmetry of the funnel chart showed that there was no publication bias in the included studies (*Figure 9*).

Discussion

The results of this meta-analysis showed that the diagnostic sensitivity of MRE was higher than that of TE for stage F0–F1 liver fibrosis. Furthermore, in the diagnosis of stage F2–F4 liver fibrosis, MRE also showed higher specificity than TE. Our results are consistent with those of previous reports (24-26).

Pathologically, liver fibrosis refers to the excessive proliferation and abnormal deposition of extracellular matrix components in liver tissues, which causes pathological structural changes and/or functional abnormalities in the liver. In essence, it is a repair response of the liver to chronic damage. The symptoms of liver fibrosis are closely related to the primary disease and the condition of the liver at the time (27,28). Some patients may experience symptoms such as fatigue, loss of appetite, and discomfort in the right upper abdomen, whereas patients with mild liver fibrosis may not exhibit any symptoms.

During the MRE examination process, a slight mechanical vibration (30–70 Hz) is transmitted to the tissue to be studied through an external vibration device, and the dynamic propagation of vibration waves in the tissue is collected by the MRI machine (29-31). In post-processing, the structure and elasticity of the tissue can be reconstructed based on the appearance (wavelength and amplitude) of the vibration wave in the tissue; through this, the softness or hardness of the tissue can be quantified. In the diagnosis of liver fibrosis, MRE also has the advantages of having simple and easy operation, strong reproducibility, and few human-dependent factors, as well as high accuracy. Moreover, it can obtain the elasticity of both the whole liver and different regions of the liver. The quantitative index is more comprehensive than liver biopsy or ultrasound elastography, as it is not affected by factors like obesity and ascites (32-34).

Instantaneous elastography is a type of ultrasound elastography technology that can be used to determine the staging of liver fibrosis through the detection of liver tissue stiffness. It has the advantages of being non-traumatic and rapid. In the assessment of the degree of liver fibrosis, the transmission speed of the shear wave in the liver is directly related to the stiffness of the liver tissue (35,36): the greater the stiffness of the liver tissue, the faster the propagation speed of the shear wave and the greater the elasticity value. Antiviral therapy can improve liver fibrosis, and the degree of liver fibrosis is an important factor in assessing the prognosis of patients (37,38). Therefore, it is of great significance to assess liver fibrosis before and during antiviral therapy.

In conclusion, the results of our meta-analysis show that MRE is superior to TE for the diagnosis of liver fibrosis of different stages in terms of sensitivity and specificity. However, there are some limitations to this meta-analysis. Firstly, it did not take into account comparisons of different age groups, and secondly, the details of heterogeneity were not analyzed. Future studies will seek to address these limitations.

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Footnote

Reporting Checklist: The authors have completed the PRISMA reporting checklist. Available at https://dx.doi.org/10.21037/apm-21-1176

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/apm-21-1176). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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