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Carotid Thin Fluttering Bands: Fact or Artifact?

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Abstract

Background: Carotid artery ultrasound is able to investigate various step of atherosclerosis progression. Thin Fluttering Bands (TFBs) have been described in carotid lumen at various stage of atherosclerosis; however the incidence reported was low.

Aim: To investigate incidence of TFBs in carotid lumen after a long time learning curve and to provide ultrasound features of such finding.

Methods: 915 patients were admitted from October 2015 to October 2016. Patients with recent of Cerebral Ischemia (CI) were excluded.

Results: TFBs were found in 96 patients (10.5%). The mean age was 64.14 ± 10.52 years. In all patients increased Intima-Media Thickness (IMT) was found. In 70 patients (72.9%) the TFB was related to a carotid plaque while in 26 (27.1%) no carotid plaque was found. Multiple TFBs were found in 11.5% of patients and the preferential carotid region was the bulb (82.6%). No significant difference in localization between right and left carotid was fond (44% left, 56% right).

Conclusion: After a long-time of learning curve we found higher incidence of TFB. The pathophysiology is still unknown; however it could be related atherosclerosis evolution.

Keywords: Artifact; Atherosclerosis; Carotid; Thin fluttering band; Ultrasound

Introduction

Atherosclerosis is a complex phenomenon than involves complex interactions among several processes as lipo-protein retention, inflammatory cell recruitment, foam cell formation, apoptosis and necrosis, Smooth Muscle Cell (SMC) proliferation and matrix synthesis, calcification, angiogenesis, arterial remodelling [1]. Carotid Ultrasound Scan (CUS) is a validated technique to assess systemic atherosclerosis and has shown high sensitivity and specificity to investigate the presence and severity of atherosclerotic disease [2,3]. Particularly, CUS is able to investigate various step of atherosclerosis progression and carotid Intima-Media-Thickness (IMT) measurement is considered as an early marker of atherosclerosis involvement [4]. In a previous paper we described presence of thin bands fluttering into carotid lumen and we postulated such finding is a step in atherosclerosis progression [5]. We found carotid Thin Fluttering Band (TFB) in 2.1% of patients who underwent CUS for atherosclerosis' screening, the majority in absence of a carotid plaque (69%) and in all cases increased IMT was observed [5].

Aim of the present study is to report last year experience in assessing TFB after a long learning curve and to describe differences between TFB and artefacts.

Methods

We included all patients admitted to our ambulatory for CUS from October 2015 to October 2016. Patients with recent ischemic stroke or transient ischemic attack were excluded to avoid potential confounding ultrasound features (i.e., intimal flap in carotid dissection or plaque's rupture). Dyslipidemia was defined as Low-Density Lipoprotein (LDL) levels ≥ 130 mg/dL or use of lipid-lowering drugs. Hypertension was defined as values of systolic blood pressure > 140 mmHg and/or > 90 mmHg of diastolic blood pressure. Diabetes was defined as fasting blood glucose of 126 mg/dl or greater. Family history of Coronary Artery Disease (CAD) was defined as a diagnosis of CAD in father/brother aged < 55 years and mother aged < 65 years. Chronic Kidney Disease (CKD) was defined as a Glomerular Filtration Rate (GFR) < 60 ml/min/1.73 m^2. Smoke was considered as a risk factor if the patient were a current smoker or an ex-smoker of less than 1 year.

TFB was defined as presence of hyperechoic fluttering band in the carotid lumen in absence of echo graphic pattern of dissection such as visualization of false lumen, low-reflection mural hematoma or thrombus or Doppler high-resistance flow [6]. All studies were performed using GE Vivid E Ultrasound system (GE Healthcare, Horten, Norway) equipped with a dedicated 8L-RS linear array transducer (4-12 MHz) by a single experienced vascular sonographer.

Study protocol

Image was optimized adjusting gain, focus and grey scale parameters. Transverse and longitudinal scans were obtained on the common carotid artery, the carotid bifurcation, internal and external carotid artery by Brightness-mode (B-mode) and color Doppler ultrasound. When longitudinal scan was performed, probe was slowly tilted from lateral to the center. IMT was defined as the distance between the leading edge of the lumen-intima echo and the leading edge of the media-adventitia echo. IMT was measured at a site free of plaque 1 cm proximal to the carotid bulb. The upper limit of normality for IMT was set according to age, gender and race as previously described [7]. We reported the IMT value according to the site of TFB, in case of bilateral TFB mean IMT value was reported. Carotid plaque was defined as the presence of focal wall thickening that is 50% greater than that of the surrounding vessel wall or as a focal region with IMT >1.5 mm echo lucent areas that protrudes into the lumen that is distinct from the adjacent boundary.

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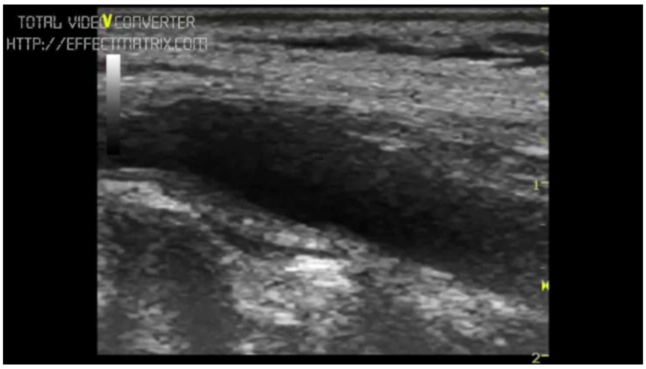
TFB was visualized in both longitudinal (Figure 1A, Video 1A), transverse B-mode scan (Figure 1B, Video 1B) and color-doppler scan (Figure 1C, Video 1C); the Motion mode (M-mode) image scan, perpendicularly oriented to the TFB, was also performed in both sections to confirm the intra-vessel location of TFB (Figure 1D). M-mode scan helped in differentiate TFB from reverberation artifacts (Video 2) or venous valve (Figure 2, Video 3).

Figure 1A: Long axis view in B-mode show the Thin Fluttering Band (TFB) in the posterior carotid wall (arrow).



Video 1A: A thin fluttering band is visualized in the posterior wall (arrow) of a carotid bulb in long.

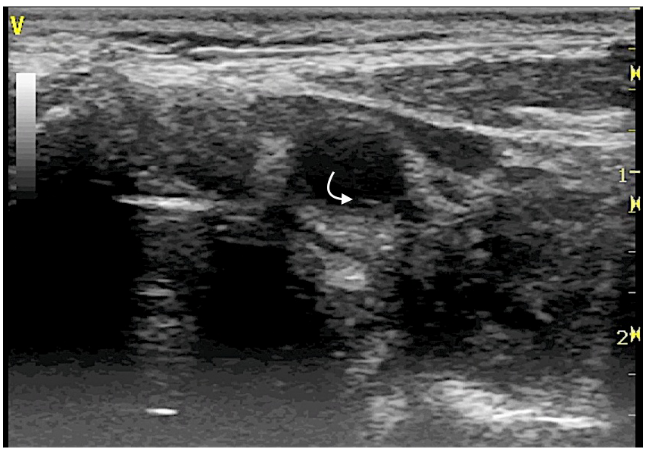


Figure 1B: Short axis view of TFB (arrow).

Video 1B: Short axis of thin fluttering band.

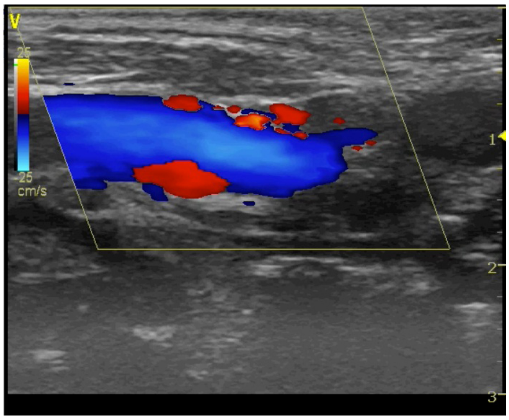
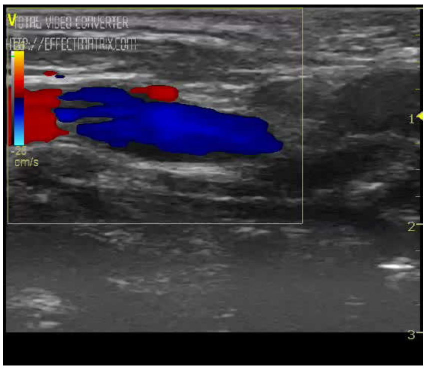


Figure 1C: Color-doppler scan shows alternation in the color in the carotid bulb.



Video 1C: Color-doppler shows alternation of the flow in the carotid bulb.

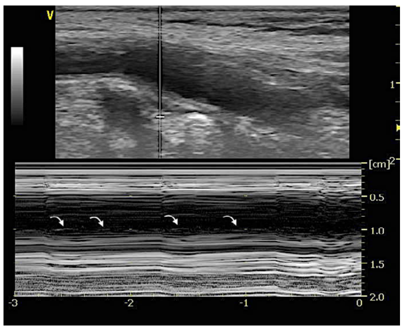
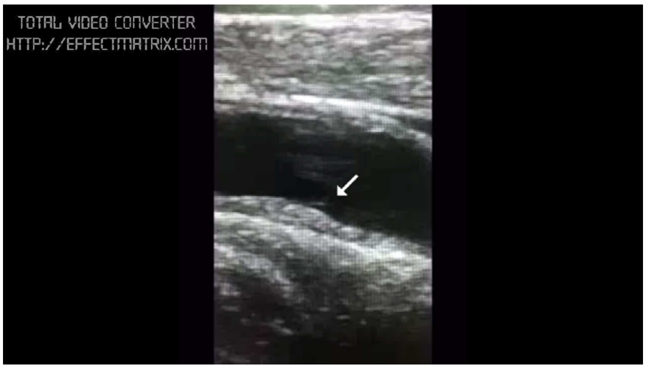


Figure 1D: M-mode scan in long axis shows the TFB (arrows) with non-consensual motion relative to the surrounding intimal layer.



Video 2: Reverberation artifact is showed as a fix hyperechoic band.

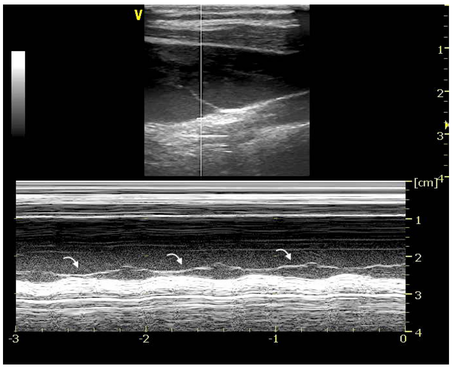


Figure 2: M-mode scan of an internal valve of jugular vein. The arrow shows the valve is thicker than TFB and has a different motion during recorded cycles.

Video 3: Long axis view of a Jugular valve.

Statistical analysis

Continuous variables are presented as mean ± standard deviation while dichotomous parameters as frequencies and percentages. The normal distribution of continuous parameters has been evaluated with the Kolmogorov-Smirnov test. Continuous data was compared using Student's unpaired T-test or the appropriate non-parametric. Categorical data was compared using the chi-square or the Fisher's test, as appropriate. SPSS 20 (IBM SPSS, Chicago, Il) was used for statistical analysis. P <0.05 was considered statistically significant.

Results

A total of 915 patients underwent CUS. TFB was identified in 96 patients (10.5%). Mean age of population was 64.14 ± 10.52. Summarizes clinical features (Table 1).

	Overall N=96	NP-TFB N=26	P-TFB N=70	p-value*
Age, mean ± SD	64.14 ± 10.52	56.35 ± 11.14	67.03 ± 8.74	0.001
IMT (mm), mean ± SD	1.15 ± 0.14	1.09 ± 0.14	1.17 ± 0.13	0.022
BMI (kg/m²), mean±SD	25.30 ± 0.27	25.10 ± 2.70	25.37 ± 2.54	0.64
Gender male, n (%)	59 (61.5)	12 (46.2)	47 (67.1)	0.060
Smoke, n (%)	49 (51.0)	11 (42.3)	38 (54.3)	0.297
Hypertension, n (%)	55 (57.3)	12 (46.2)	43 (61.4)	0.179
Diabetes, n (%)	16 (16.7)	2 (7.7)	14 (20)	0.22
Dyslipidemia, n (%)	59 (61.5)	14 (53.8)	45 (64.3)	0.35
Family history of CAD, n (%)	26 (27.1)	8 (30.8)	18 (25.7)	0.615
CKD, n (%)	5 (5.6)	1 (3.8)	3 (4.3)	0.059

Table 1: Baseline characteristics of population.

NP-TFB: Non Plaque-related Thin Fluttering Band; P-TFB: Plaque related Thin Fluttering Band; SD: Standard Deviation; IMT: Intima-Media Thickness; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; CAD: Coronary Artery Disease; CKD: Chronic Kidney Disease.

**p calculated among groups*

In all patients we found increased intima media thickness (IMT – mean 1.15 ± 0.14); in 70 patients (72.9%) TFB was found in presence of a plaque while in 26 patients (27.1%) no carotid plaque was observed (Figure 3, Video 4). TFB was single in most of patients (n=85, 88.5%) while in 11 patients (11.5%) it was multiple. Total TFBs observed were 109, 61 (56 %) in the right carotid and 48 (44%) in the left carotid. The majority originated in the carotid bulb (82.6%) followed by the internal carotid artery (10.1%) and the common carotid artery (7.3%).

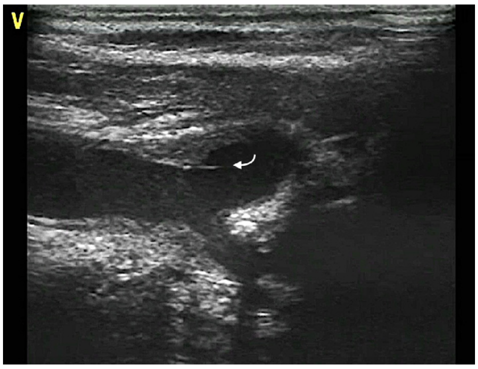


Figure 3: A plaque with a TFB is observed in the bulb of a right carotid artery.

Patients with plaque were significantly older (67.03 ± 8.74 vs 56.35 ± 11.14 years, p < 0.001) and cardiovascular risk factors were more prevalent without any statistical significant difference.

Discussion

In this series we found higher incidence of TFB respect to our previously published study (10.5% vs 2.1%). Lower incidence in our previous report could be due to the learning curve. Indeed, the application of our protocol allowed us to recognize more TFBs than the past. In particular, slow progression from lateral to central position during longitudinal examination and execution of M-mode scan are crucial

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Video 4: Long axis view of a carotid plaque with a TFB.

to evaluate the carotid vessel accurately. Several echo graphic findings differentiate TFB from artifacts such as reverberation or venous valve reflection: 1) TFB is visualized in both transverse and longitudinal section while artifacts typically disappear when changing insonification angle; 2) TFB has a cyclic undulatory motion in B-mode scan and in M-mode scan it shows a peculiar non-consensual motion relative to the surrounding intimal layer while reverberation artifacts are fix in the carotid lumen video 2; conversely, venous valve is thicker than TFB with a different and opposite motion (Figure 2, Video 3).

This study also confirm the previous observation that most of TFBs originated in the carotid bulb, a well known site of disturbed flow where alternation of color doppler are frequently found in presence of TFB (Figure 1C, Video 1C).

Respect to the previously reported series we found higher prevalence of TFBs related to carotid plaque. Ultrasound characteristics of P-TFB are comparable to those found in NP-TFB indeed TFB co-localize with augmented IMT therefore we believe that TFB is not a structure related to the plaque. The increased IMT found in P-TFB group could be explained by the different atherosclerotic stage of patient with carotid plaque respect to those without carotid plaque.

A practical tip that may help in visualize TFB is to tilt slowly the probe from lateral to the center in longitudinal scan when focal augmented IMT is associated with large disturbed flow (alternation of color) in carotid bulb.

Although the pathophysiology of TFB is still unknown, also in this report all patients showed increased IMT, therefore we can speculate that TFB occurs in a precocious stage of atherosclerotic involvement and it could be a dynamic phenomenon of vessel remodeling. Endothelial Shear Stress (ESS) alteration, commonly observed in the carotid bulb, triggers expression of several factors such as adhesion molecules, chemokines and pro-inflammatory cytokines [8-10]. Intimal layer adapts in response to changes in ESS and tensile stress through several dynamic process (REF) that lead to progressive thickening of such tunica, therefore TFB could be the expression of intimal turnover [11].

Limitations

This study does not provide information about physiopathological mechanisms of TFB formation and structure; however it was beyond our scope. Also, no alternative imaging technique such magnetic resonance imaging or computed tomography scan was performed as previous report did not show any advantage of such technique in identifying TFB. In this study only a single expert operator perform the examinations, however in our previous report no significant inter-observer variability for the diagnosis of TFB was found [5]. Another limitation is that we could not provide information about structure of TFB as vascular ultrasound is the only imaging technique we used. Optical Coherence Tomography (OCT) or Intravascular Ultrasound (IVUS) could provide characterization of TFB structure.

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