

Standing waves in a patient with systemic scleroderma

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Abstract

Standing waves are a very rare angiographic image with an unclear etiology. Many theories have been developed to explain this phenomenon, but none have been confirmed. We present an interesting case of a 57-year-old woman, whose angiography showed standing waves along the entire length of the superficial femoral artery. On admission, the patient's general condition was fairly good. No significant abnormalities were observed in the P-A chest feet and hands X-ray, as well as in the ultrasound of the abdominal cavity and pelvis. On March 8, the patient underwent angiography documenting the presence of regular "goose trachea-like" 'notched walls' over the entire length of the right superficial femoral artery. Angiography was then followed by an ultrasound exam of femoral arteries, however, no femoral artery wall changes were seen. The diagnosis was standing waves. Moreover, extensive diagnostics for systemic disease, as well as the overall clinical picture allowed for the diagnosis of systemic scleroderma.

Standing waves are a rare phenomenon, harmless to the patient's life and health. Researchers have put forward many theories to explain its unclear etiology. The presence of standing waves has also been reported with the coexistence of diseases such as Buerger's, Tolos-Hunt's, or rheumatic heart disease. Moreover, it is worth mentioning the possibility of misdiagnosing standing waves as FMD.

To summarize, standing waves are a harmless phenomenon. Despite its rare occurrence, it is worth remembering not to misdiagnose it and consequently, implement unnecessary diagnostics and treatment and cause superfluous anxiety in the patient.

Key words: standing waves; angiography; ultrasonography; vascular disease; systemic scleroderma

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Introduction

Standing waves are a very rare angiographic image with an unclear etiology. Many theories have been developed to explain this phenomenon, including mechanical failure of the vessel wall due to high blood

pressure, longitudinal constriction of the arterial wall, and retrograde flow due to contrast load injection, but none have been confirmed [1–4]. Moreover, the data in the available literature indicate the presence of standing waves with various diseases, e.g. Buerger's disease or together with a local trauma [2, 5]. However,

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the phenomenon, already described at the beginning of the previous century, remains shrouded in mystery and with time has been found in subsequent types of imaging examinations, not only angiography [6, 7]. We present an interesting case of a 57-year-old woman with a non-healing wound on the hallux of her right foot, with a rich medical history, whose angiography showed standing waves along the entire length of the superficial femoral artery.

Case report

A 57-year-old patient was admitted to the Angiology Clinic of the University Hospital in Wrocław in March this year due to a six-month non-healing ulcer of the right foot hallux. In the history, the patient reported a loss of 40 kg (caused by loss of appetite), COPD (a long-term smoker), arterial hypertension, state after hypertensive crisis 15 years ago, for 20 years symptoms of Raynaud's syndrome (currently does not confirm paroxysmal paling) and the state after Covid-19 infection at the turn of October and November of the previous year (vaccinated with 2 doses of the vaccine).

On admission, the patient's general condition was fairly good. The attention was drawn to the deep trophic ulceration on the dorsal surface of the hallux. Physical examination revealed no edema, visible varicose veins of the lower extremities, and an undetectable pulse in the peripheral arteries. Additionally, the erythematous rash on the hands, forearms, and face attracted attention. The telangiectatic changes on the hands and face have been present for many years. In addition, there was hardening and bruising of the fingers, changes to the nails, and minor erosions on the fingertips. The patient underwent extensive diagnostic tests. No significant abnormalities were observed in the P-A chest feet and hands X-ray, as well as in the ultrasound of the abdominal cavity and pelvis.

On March 8, the patient underwent angiography documenting the presence of regular "goose trachea-like" 'notched walls' over the entire length of the right superficial femoral artery (Fig. 1). In addition, obstruction of the right posterior tibial artery, the distal segment of the dorsal artery, and the plantar arch of the right foot were observed. Angiography was then followed by an ultrasound exam of femoral arteries, however, no femoral artery wall changes were seen (Fig. 2). The characteristic picture of vascular changes with many years of nicotine history suggested the suspicion of thrombo-obliterative vasculitis. The differential diagnosis of "notched walls" included Buerger's disease, fibromuscular dysplasia (FMD), and standing waves. Despite the nicotine history, Buerger's disease was excluded due to the lack of other characteristic features

of this disease entity. The lack of typical localization and regular and transient changes, which is characteristic of standing waves, contributed to the rejection of fibromuscular dysplasia.

Moreover, extensive diagnostics for systemic disease with documented immunological exponents- increased ANA levels 1:3200, SCL 70 (+++), the presence of cryoglobulins, hyperfibrinogenemia, increased ferritin levels, and transient retention of nitrogen metabolites in the stage of G3b renal failure, proteins shift in electrophoresis, elevated ESR, a capillaroscopic image indicating the presence of R loops and avascular regions, as well as the overall clinical picture allowed for the diagnosis of systemic scleroderma. During hospitalization, a high-resolution CT scan of the chest was additionally performed, showing no significant changes, as well as a gastroscopic examination, which documented pathognomonic for scleroderma gastroesophageal reflux with erosion over the cardia.

Discussion

Standing waves are a rare phenomenon, harmless to the patient's life and health [1, 5]. Researchers have put forward many theories to explain its unclear etiology. Initially, it was thought that it might be caused by wall contraction, which was confirmed by the argument of the disappearance of the phenomenon after the administration of vasodilators. However, this claim was questioned due to the widening of the walls as well [1–3]. The presence of standing waves as an artifact in classical angiography, or the effect caused by backflow after contrast administration, were naturally excluded due to reports of their occurrence also in magnetic resonance or sonographic examinations [2–7]. However, it seems, that Jacobsen et al., who developed an anisotropic model of the vessel, are the closest to explaining this phenomenon. The results of his experiment show that standing waves are not caused by mechanical damage to the vessel due to high blood pressure, or by

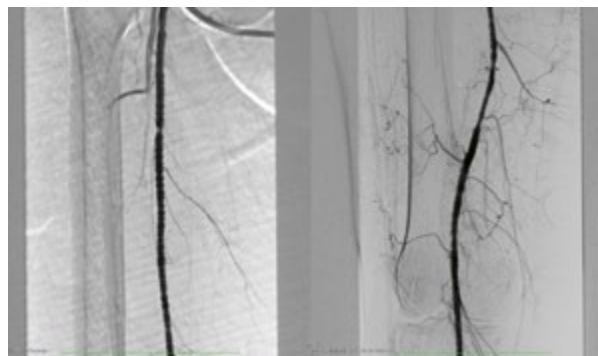


Figure 1. "Goose trachea like" 'notched walls' over the entire length of the right superficial femoral artery in Angiography

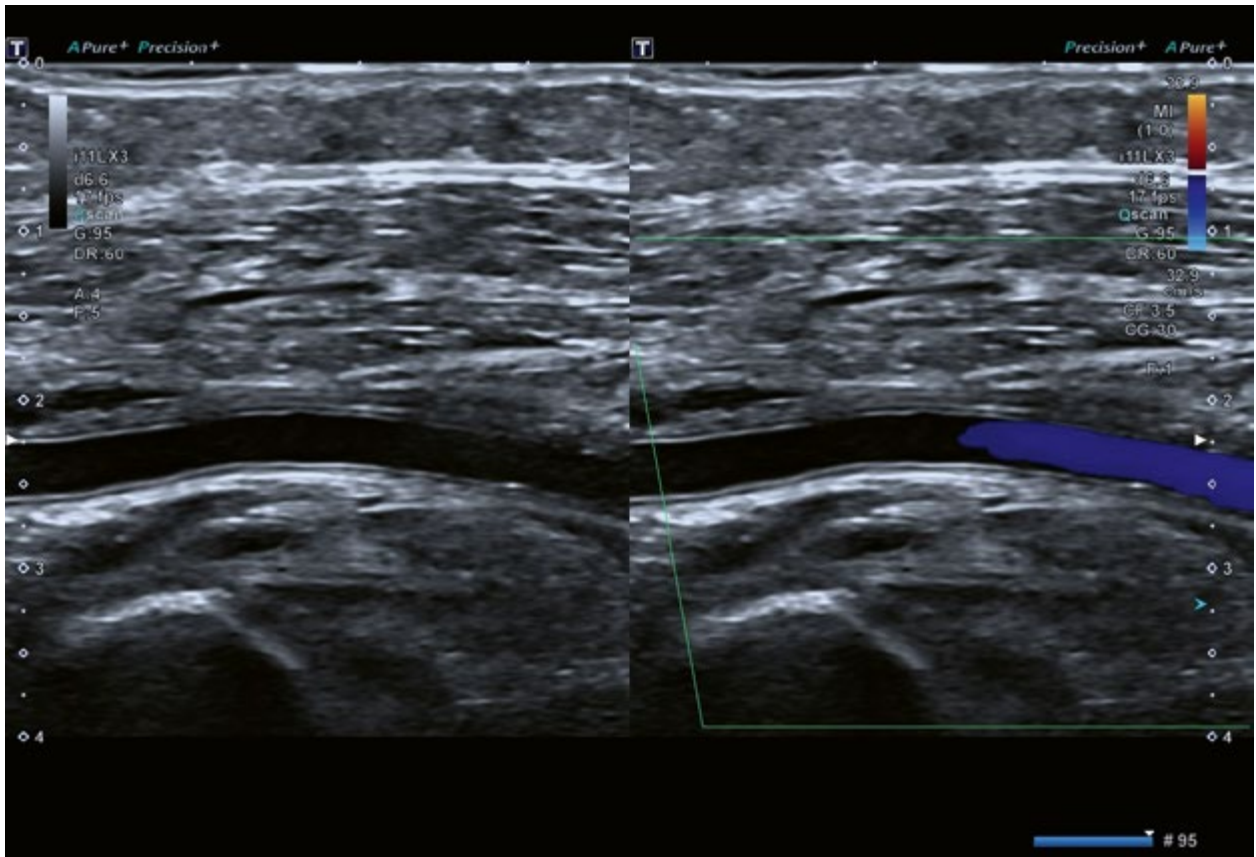


Figure 2. No changes in the right superficial femoral artery in ultrasonography

standing pressure waves caused by the heartbeat. However, he points to the general instability of the vessel wall as the main cause, which provides to endothelial hyperpermeability followed by fibrinous local necrosis [2]. It is worth adding, that none of the aforementioned theories has been unequivocally confirmed.

The presence of standing waves has also been reported with the coexistence of diseases such as Buerger's, Tolos-Hunt's, or rheumatic heart disease [2, 8, 9]. There are also reports of their co-occurrence with local trauma or popliteal arterial emboli [5, 9]. Our case, according to the available knowledge, is the first one that describes the presence of standing waves and systemic sclerosis simultaneously.

Moreover, it is worth mentioning the possibility of misdiagnosing standing waves as FMD. This may not only cause unnecessary anxiety in the patient but also lead to the introduction of superfluous diagnostics and therapy. Standing waves will reveal regular and transient changes, while in the FDA they will be more asymmetric and irregular. Additionally, changes in FMD are most common in extracranial carotid, vertebral and renal arteries, while in standing waves they are typically found in the superficial femoral artery [5, 10]. It cannot be forgotten that there have been some papers in which standing waves were taken into account as a precursor

to FMD [1, 6]. In our patient, diagnosed with systemic sclerosis, we hypothesize, that endothelial injury present in systemic autoimmune disease contributed to vascular wall reaction to contrast media, and quickly disappeared after the exam.

Conclusions

To summarize, standing waves are a harmless phenomenon with an unclear etiology. It can occur with various disease entities, including systemic sclerosis. Despite its rare occurrence, it is worth remembering not to misdiagnose it and consequently, implement unnecessary diagnostics and treatment and cause superfluous anxiety in the patient.

Conflict of interest

None.

References

1. Lehrer H. The physiology of angiographic arterial waves. *Radiology*. 1967; 89(1): 11–19, doi: [10.1148/89.1.11](https://doi.org/10.1148/89.1.11), indexed in Pubmed: [6027317](https://pubmed.ncbi.nlm.nih.gov/6027317/).

2. Jacobsen JC, Beierholm U, Mikkelsen R, et al. „Sausage-string” appearance of arteries and arterioles can be caused by an instability of the blood vessel wall. *Am J Physiol Regul Integr Comp Physiol.* 2002; 283(5): R1118–R1130, doi: [10.1152/ajpregu.00006.2002](https://doi.org/10.1152/ajpregu.00006.2002), indexed in Pubmed: [12376405](https://pubmed.ncbi.nlm.nih.gov/12376405/).
3. Bartley O, Wickbom I, Bartley O, et al. Arterial spasm in peripheral arteriography using the catheter method. *Acta radiol.* 1957; 47(6): 433–448, doi: [10.3109/00016925709170918](https://doi.org/10.3109/00016925709170918), indexed in Pubmed: [13444054](https://pubmed.ncbi.nlm.nih.gov/13444054/).
4. Joseph JM, Doenz F, Mosimann F. [„Standing waves”: differential diagnosis of fibromuscular dysplasia]. *Helv Chir Acta.* 1994; 60(6): 897–899, indexed in Pubmed: [7876008](https://pubmed.ncbi.nlm.nih.gov/7876008/).
5. Rasheed A, White SB, Bhalla M. Standing waves on computed tomography angiography in multiple vessels in a young trauma patient. *J Comput Assist Tomogr.* 2021; 45(2): 238–241, doi: [10.1097/RCT.0000000000001137](https://doi.org/10.1097/RCT.0000000000001137), indexed in Pubmed: [33661157](https://pubmed.ncbi.nlm.nih.gov/33661157/).
6. Peynircioglu B, Cil BE, Peynircioglu B, et al. Standing or stationary arterial waves of the superior mesenteric artery at MR angiography and subsequent conventional arteriography. *J Vasc Interv Radiol.* 2007; 18(10): 1329–1330, doi: [10.1016/j.jvir.2007.07.005](https://doi.org/10.1016/j.jvir.2007.07.005), indexed in Pubmed: [17911528](https://pubmed.ncbi.nlm.nih.gov/17911528/).
7. Kröger K, Massalha K. Sonographic correlate of stationary waves. *J Clin Ultrasound.* 2004; 32(3): 158–161, doi: [10.1002/jcu.20006](https://doi.org/10.1002/jcu.20006), indexed in Pubmed: [14994259](https://pubmed.ncbi.nlm.nih.gov/14994259/).
8. Kettler HL, Martin JD. Arterial stationary wave phenomenon in Tolosa-Hunt syndrome. *Neurology.* 1975; 25(8): 765–770, doi: [10.1212/wnl.25.8.765](https://doi.org/10.1212/wnl.25.8.765), indexed in Pubmed: [1171409](https://pubmed.ncbi.nlm.nih.gov/1171409/).
9. Steinberg I. Stationary waves of the superficial femoral arteries. Report of a case occurring in a patient with rheumatic heart disease and popliteal arterial emboli. *Am J Roentgenol Radium Ther Nucl Med.* 1966; 98(4): 901–906, doi: [10.2214/ajr.98.4.901](https://doi.org/10.2214/ajr.98.4.901), indexed in Pubmed: [5924363](https://pubmed.ncbi.nlm.nih.gov/5924363/).
10. Sharma AM, Gornik HL. Standing arterial waves is NOT fibromuscular dysplasia. *Circ Cardiovasc Interv.* 2012; 5(1): e9–e11, doi: [10.1161/CIRCINTERVENTIONS.111.967828](https://doi.org/10.1161/CIRCINTERVENTIONS.111.967828), indexed in Pubmed: [22338008](https://pubmed.ncbi.nlm.nih.gov/22338008/).