Diagnostic yield of facial artery ultrasound in addition to temporal and axillary artery ultrasound for the diagnosis of giant cell arteritis

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Abstract

Objective

Ultrasound of the temporal and axillary arteries is recommended as the first-line imaging test for suspected giant cell arteritis (GCA), but the additional diagnostic yield of facial artery ultrasound (facUS) remains unclear.

Methods

In this retrospective study, patients with suspected GCA who underwent standardised ultrasound of the temporal arteries (tempUS) and axillary arteries (axUS) were included if both facial arteries had also been examined. Clinical, laboratory, sonographic and histopathological data were retrieved from the electronic medical records. The diagnostic accuracy of facUS was determined by ROC-curve analysis and 2x2 contingency tables. Patients with and without facial artery involvement were compared by univariate significance tests.

Results

Among 69 included patients, 37 were diagnosed with GCA and 32 with other conditions. FacUS-values ≥0.7 mm were found in 34 patients (26 GCA, 8 non-GCA) and ≥1.0 mm in 18 patients (17 GCA, 1 non-GCA). When facUS was added to tempUS and axUS, sensitivity increased to 97.3% (+8.1%) but specificity decreased to 65.6% (-18.8%) when a cut-off ≥0.7 mm was applied. With a cut-off ≥1.0 mm, diagnostic accuracy changed only marginally. Eleven patients showed negative tempUS but positive facUS results; five of them were ultimately diagnosed with GCA (three of whom had isolated facial artery involvement).

Conclusion

FacUS provides limited additional diagnostic yield when added to temporal and axillary artery imaging in suspected GCA but may be performed in selected patients with strong clinical suspicion and negative temporal ultrasound findings.

Key words

giant cell arteritis, ultrasound, sonography, facial arteries

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Introduction

Giant cell arteritis, the most common form of the large vessel vasculitides, is a disease of elderly patients aged ≥50 years (1). In recent years, international guidelines and expert recommendations set a frame for the rational diagnostic workup in suspected GCA (2-4) and important studies on the effect of biological treatment approaches on the disease course of GCA have brought the disease stronger into the focus of the scientific community (5-7).

Both genetic and environmental factors contribute to the different clinical disease manifestations and arterial distribution patterns (1). While extracranial arterial involvement has been increasingly recognised as important disease feature in the past two decades (8), involvement of the cranial arteries still represents the most common and most important disease manifestation, carrying the risk of severe ocular ischaemic complications early during the disease course (9, 10).

Ultrasound of the temporal arteries (tempUS) and axillary arteries (axUS), a diagnostic modality facilitating fast track approaches in order to avoid ocular ischaemic complications before treatment onset, is nowadays recommended as first-line diagnostic imaging (2). Besides the superficial temporal arteries, the facial arteries can be involved in the vasculitic process and are easily accessible by ultrasound. Only limited data are available on the diagnostic benefit of ultrasound of the facial arteries facUS in suspected GCA, and facUS has not been included in established scores for structured sonographic GCA-assessment (11) We sought to evaluate the additional diagnostic yield of facUS in addition to tempUS and axUS in the diagnostic workup of suspected GCA.

Patients and methods

Study cohort

Patients with a clinical suspicion of GCA who underwent a standardised sonographic study of the temporal and axillary arteries between October 2016 and April 2025 were included in this retrospective study, if additionally, the bilateral facial arteries had been investigated. Clinical, laboratory and sonographic imaging data were extracted from the electronic medical records. For analysis of humoral inflammatory markers (C-reactive protein, erythrocyte sedimentation rate), values obtained immediately before treatment initiation were chosen. If available, histological results of temporal artery biopsy (TAB) were collected. A final clinical diagnosis of GCA was established based on comprehensive assessment of clinical presentation, laboratory findings, imaging and biopsy results, applying modified diagnostic criteria as follows: 1. age >50 years; 2. typical cranial symptoms (new onset, persisting headache, jaw claudication, temporal artery tenderness); 3. extracranial symptoms (polymyalgia rheumatica, new onset upper extremity claudication, fever of unknown origin); 4. C-reactive protein ≥1 mg/dl (normal range <0.5 mg/dl); 5. typical imaging findings in vascular sonography or positive temporal artery biopsy For a diagnosis of GCA, patients had to fulfil at least three of these criteria (12). In addition, patients had to meet at least six points in the 2022 ACR/EULAR classification system for GCA (4). In ambiguous cases, a final consensus diagnosis was established after detailed case review by two of the authors with long standing experience in the diagnosis of GCA (C.G., M.C.), taking into account the follow-up of these patients at six months.

Ultrasound methodology

Sonographic examinations were performed according to a standardised institutional protocol using a LOGIQ E9 machine (General Electric, Milwaukee, USA). The cranial arteries (superficial temporal artery in its preauricular course, frontal and parietal branches at the level of the upper margin of the auricle, facial arteries at their crossing point with the mandible) were evaluated by high-resolution compression sonography (hrCS) using an 18 MHz hockey-stick transducer. The default settings were as follows: B-Mode frequency 18.0 MHz, Doppler frequency 7.5 MHz, pulse repetition frequency (PRF) 2.4 kHz. For hrCS, gentle pressure was applied with the transducer to induce lumen collapse. Wall thickness, defined as the sum of near- and far-wall intima-media thickness (IMT), was measured in B-mode in the transverse plane at the site of wall thickening, perpendicular to the vessel wall and expressed in millimetres (13).

The axUS-examinations comprised B-mode and colour duplex sonography of the bilateral axillary arteries in longitudinal and transversal planes via the sub-clavicular fossa. For this purpose, a linear multifrequency transducer was used, with default settings as follows: B-Mode frequency 8.4 MHz; Doppler frequency 4.0 MHz; pulse repetition frequency 3.5 kHz. Focus, B-Mode and colour gain, as well as PRF were dynamically adjusted, as required for optimal visualisation of the vessel wall. IMT of the far wall of the axillary artery was measured in the longitudinal plane at the level of the origin of the subscapular artery (third axillary artery segment) (14).

Table I. Comparison of patients with and without a final diagnosis of GCA in the overall cohort.

	Alternative diagnosis n=32	Giant cell arteritis n=37	*p*-value
Age, years (mean ± SD)	66.4 ± 9.8	71.7 ± 9.5	0.02
Female sex, n (%)	12 (37.5)	19 (51.4)	0.18
Fever, n (%)	4 (12.5)	4 (10.8)	1.00
Night sweats, n (%)	5 (15.6)	7 (18.9)	0.76
Weight loss, n (%)	4 (12.5)	12 (35.1)	0.05
Polymyalgia rheumatica, n (%)	12 (37.5)	7 (18.9)	0.11
Upper extremity claudication, n (%)	1 (3.1)	0	0.73
Headache, n (%)	13 (40.6)	20 (54.1)	0.34
Jaw claudication, n (%)	7 (21.9)	27 (73.0)	**<0.01**
Scalp tenderness, n (%)	5 (15.6)	5 (13.5)	1.00
Temporal artery tenderness, n (%)	4 (12.5)	8 (21.6)	0.36
Transient vision loss, n (%)	2 (6.3)	5 (13.5)	0.44
Permanent vision loss, n (%)	8 (25)	11 (29.7)	0.79
Prednisolone treatment, n (%)	21 (65.6)	37 (100)	**<0.01**
C-reactive protein, mg/dl (mean ± SD)	2.5 ± 4.6	4.6 ± 4.4	**<0.01**
Erythrocyte sedimentation rate, mm/1 hour (mean ± SD)	24 ± 33	44 ± 30	**<0.01**
tempUS IMT, mm (mean ± SD)	0.50 ± 0.14	0.94 ± 0.42	**<0.01**
axUS IMT mm (mean ± SD)	0.76 ± 0.23	1.09 ± 0.64	**<0.01**
facUS IMT mm (mean ± SD)	0.55 ± 0.21	1.01 ± 0.51	**<0.01**
Temporal artery biopsy performed, n (%)	10 (31.3)	10 (27.0)	0.79
Temporal artery biopsy positive, n (%)	0	4 (40)	**0.09**

*missing values in 13 patients, leaving 56 patients for analysis.

Assessment of ultrasound images and definitions

All digitally stored ultrasound images were reviewed and reassessed with regard to wall thickness. A noncompressible Halo sign of ≥0.7 mm (sum of the near and far wall IMT) in one or more temporal artery branches was considered to be indicative for cranial GCA (13). A circumferential, hypoechogenic thickening of the far wall axillary artery intima media thickness (axIMT) ≥1.2 mm in the third axillary artery segment, at the level of the subscapular artery origin, was considered to be positive for extracranial GCA (14). The facial artery wall thickness was analysed exploratively, as outlined below. Furthermore, based on the above-mentioned cut-off-values for the superficial temporal arteries and on our clinical experience, we chose to analyse distinct cut-off-values of ≥0.7 mm and ≥1.0 mm in more detail with regard to their diagnostic accuracy.

Statistical analysis

For statistical analysis, SPSS 29.0 (IBM Corp., Armonk, NY, USA) was applied. Patients with and without a fnal diagnosis of GCA were compared with regard to clinical characteristics, laboratory findings and temporal artery biopsy results. Comparisons were further made between GCA-patients with and without a positive facUS-study. Receiver-operator-characteristics (ROC)-analysis was performed to determine optimal cut-off-values of facial artery IMT for the diagnosis of GCA. The diagnostic yield of facUS in addition to tempUS and axUS with respect to the final clinical diagnosis was calculated by using 2×2 contingency tables. A separate analysis for diagnostic accuracy was performed for the subgroup of patients with permanent visual loss. Univariate group comparisons were performed using c^2-test (categorical variables) and Mann-Whitney-U-test (continuous variables). Two-sided *p*-values were considered significant. Correlation between continuous variables was tested by calculating Pearson`s rho.

Results

From 439 records of patients with suspected GCA, 149 had complete clinical data and digitally stored sonographic imaging data with adequate image documentation. Out of these, 69 patients had undergone facial artery ultrasound which were included in the analysis. Thirty-seven of 69 patients received a final diagnosis of GCA, whereas 32 patients were diagnosed with alternative conditions. The clinical characteristics of patients with and without a final diagnosis of GCA are compared in Table I. FacUS exhibited values of ≥0.7 mm in 34 patients (26 and 8 patients with and without a final diagnosis of CGA, respectively) (Fig. 1). Six of the 8 non-GCA-patients (75%) with facUS-values ≥0.7 mm were men. FacUS-values ≥1.0 mm were found in 18 patients (17 with and 1 without a final diagnosis of CGA). Eleven of the 17 GCA-patients (64.7%) with facUS-values ≥1.0 mm were men. Bilateral facial artery wall thickening was found in 16 of 26 patients (61.5%) with a final diagnosis of GCA and in 3 out of 8 patients (37.5%) without a final diagnosis of GCA. A comparison of patients with a final diagnosis of GCA and positive vs. negative facUS-study (cut-off ≥1.0 mm) is given in Table II. Patients with facial artery involvement had significantly higher CRP-levels and higher mean values of the maximum temporal artery wall thickness, while there were no meaningful clinical differences.

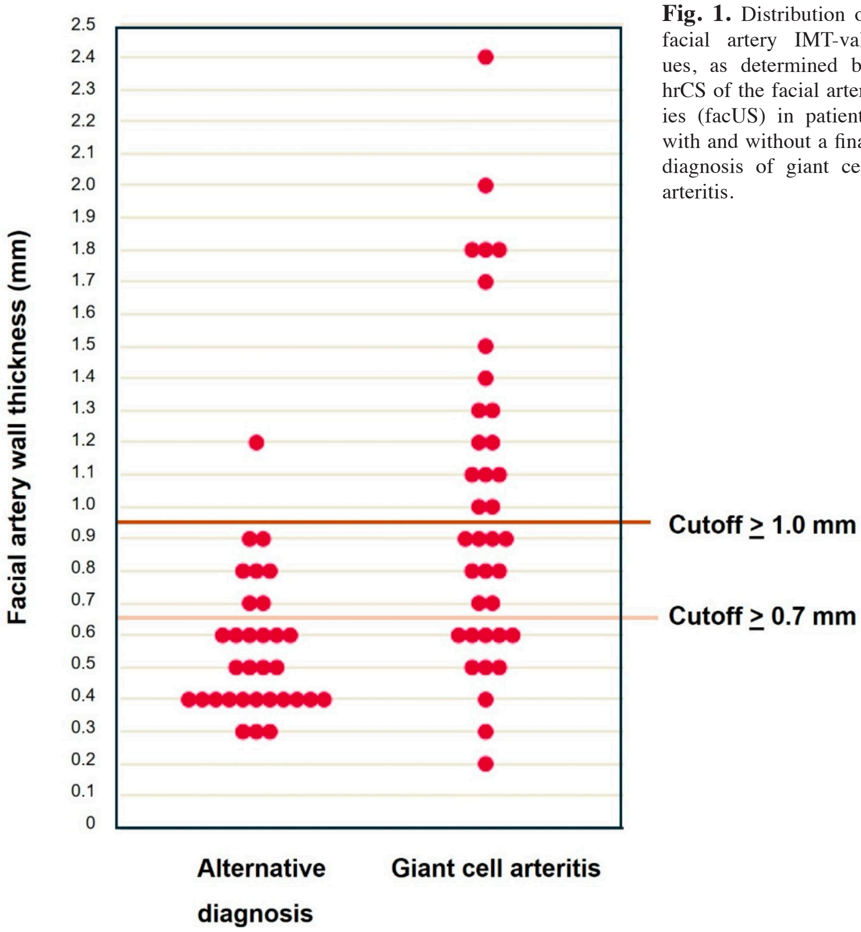

Fig. 1. Distribution of facial artery IMT-values, as determined by hrCS of the facial arteries (facUS) in patients with and without a final diagnosis of giant cell arteritis.

Table II. Comparison of patients with a final diagnosis of GCA based on a positive or negative facUS study (cut-off ≥1.0 mm).

	facUS negative n=20	facUS positive n=17	*p*-value
Age, years (mean ± SD)	70.5 ± 10.6	73.1 ± 8.1	0.50
Female sex, n (%)	7 (35)	11 (64.7)	0.10
Fever, n (%)	2 (10)	2 (11.8)	1.0
Night sweats, n (%)	3 (15)	4 (23.5)	0.68
Weight loss, n (%)	9 (45	4 (23.5)	0.3
Polymyalgia rheumatica, n (%)	3 (15)	4 (23.5)	0.68
Upper extremity claudication, n (%)	1 (5.3)	0	1.0
Headache, n (%)	10 (50)	10 (58.8)	0.74
Jaw claudication, n (%)	13 (65)	14 (82.4)	0.29
Scalp tenderness, n (%)	3 (15)	2 (11.8)	1.0
Temporal artery tenderness, n (%)	5 (25)	3 (17.6)	0.70
Transient vision loss, n (%)	1 (5.0)	4 (23.5)	0.49
Permanent vision loss, n (%)	4 (20.0)	7 (41.2)	0.28
C-reactive protein, mg/dl (mean ± SD)	3.3 ± 4.7	6.1 ± 3.7	**<0.01**
Erythrocyte sedimentation rate, mm / 1 hour (mean ± SD)	40 ± 33	50 ± 26	0.40
tempUS IMT mm (mean ± SD)	0.77 ± 0.37	1.14 ± 0.41	**<0.01**
axUS IMT mm (mean ± SD)	1.23 ± 0.78	0.90 ± 0.34	0.39
Temporal artery biopsy performed, n (%)	7 (35)	3 (17.6)	0.29
Temporal artery biopsy positive, n (%)	2 (28.6)	2 (66.7)	0.5

*missing values in 3 patients, leaving 34 patients for analysis.

Mean values of maximum facial and temporal artery IMT showed significant (moderate) correlation (Pearson's rho 0.61, $p<0.01$).

When facUS was analysed as a standalone test, the area under the curve of the diagnostic accuracy for the diagnosis of GCA was 0.8 (Fig. 2). With a cut-off of ≥0.7 mm, sensitivity and specificity of facUS for the diagnosis of GCA were 70.3% and 75%, whereas with a cut-off of ≥1.0 mm sensitivity and specificity were 45.9% and 96.9%. Combined tempUS and axUS had a sensitivity and specificity of 89.2% and 84.4% for the diagnosis of GCA and 33 of 37 patients with a final diagnosis of GCA had a positive tempUS and/or axUS-study, respectively. Changes in the diagnostic accuracy, when facUS-results were considered in addition to tempUS and axUS are given in Table III. When applying a facUS cut-off-value ≥0.7 mm, sensitivity and specificity changed to 97.3% (+8.1%) and 65.6% (-18.8%), whereas sensitivity and specificity were 91.9% (+2.7%) and 84.4% (±0%), when a cut-off-value of ≥1.0 mm was considered. Overall, 11 patients had a negative tempUS-study but exhibited typical wall thickening in at least one facial artery in facUS (10 patients with wall thickening between 0.7 and 0.9 mm, 1 patient with wall thickening ≥1.0 mm). Five of these patients received a final diagnosis of GCA, two of whom with additional axillary artery involvement and three of whom had isolated facial artery involvement (bilateral in one case). In the remaining six patients, a diagnosis of GCA was eventually excluded and facial artery wall thickening was considered to be falsely positive.

In the subgroup of patients with permanent visual loss (n=19), the combination of facUS with tempUS and axUS did not change diagnostic accuracy when a cut-off of ≥1.0 mm was applied (sensitivity 90.9% and specificity 75% with and without consideration of facUS-values). With a cut-off of ≥0.7 mm, sensitivity increased slightly to 100% (+ 9.1%), but specificity diminished to 50% (-25%).

Discussion

GCA with biopsy proven facial artery involvement has been described only occasionally (15). More than 20 years ago, Schmidt *et al.* described involvement of the facial arteries in 3 out of 30 patients with GCA in a detailed ultrasonographic study (16). However, it was only in recent years, that the facial arteries were increasingly included in

Table III. Diagnostic accuracy of ultrasound of different arterial segments and their combination.

	Positive predictive value (%)	Negative predictive value (%)	Sensitivity (%)	Specificity (%)
Single vascular territories				
Superficial temporal arteries	87.5	75.7	75.7	87.5
Facial arteries, cut-off ≥0.7 mm	76.5	68.6	70.3	75
Facial arteries, cut-off ≥1.0 mm	94.4	60.8	45.9	96.9
Combined vascular territories				
Axillary arteries	92.3	55.4	32.4	96.9
Superficial temporal + axillary arteries	86.8	87.1	89.2	84.4
Superficial temporal + facial arteries, facial artery cut-off ≥0.7 mm	76.7	84.6	89.2	68.8
Superficial temporal + facial arteries, facial artery cut-off ≥1.0 mm	87.5	75.7	75.7	87.5
Superficial temporal + axillary arteries + facial arteries, facial artery cut-off ≥0.7 mm	76.6	95.5	97.3	65.6
Superficial temporal + axillary arteries + facial arteries, facial artery cut-off ≥1.0 mm	87.2	90	91.9	84.4

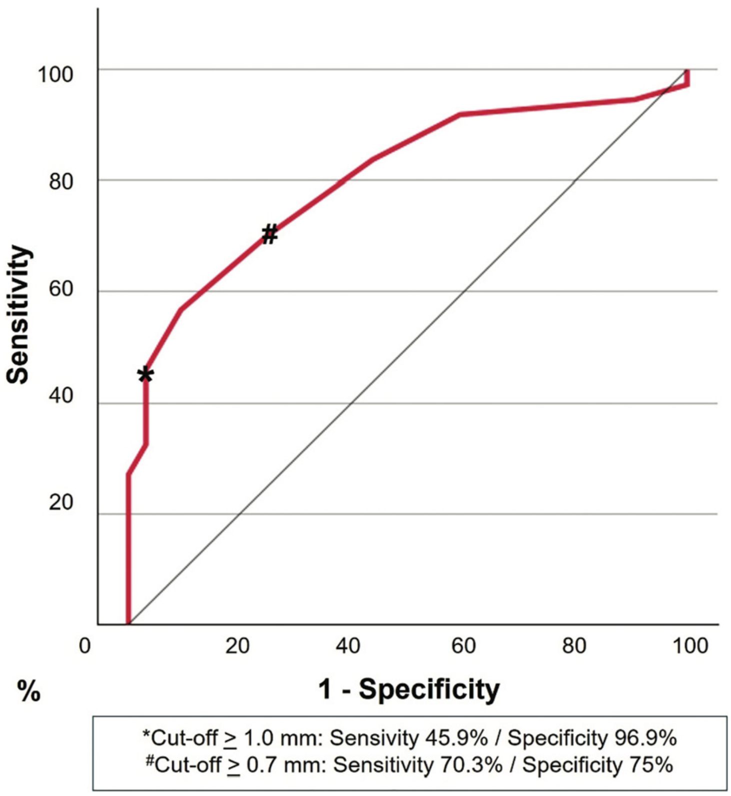

Fig. 2. Trade-off of sensitivity and specificity of facial artery IMT-values, as determined by hrCS of the facial arteries (facUS), for the diagnosis of giant cell arteritis.

ultrasound protocols in studies on the diagnosis and disease patterns of GCA (12, 17-20). The diagnostic benefit of facUS in addition to established ultrasound protocols such as tempUS and axUS has not yet been precisely defined.

We found limited specificity of hrCS-cut-off-values established for the superficial temporal arteries ≥0.7 mm) (13), when applied for the facial arteries in the diagnostic workup of suspected GCA. In addition to the established protocol of combined tempUS and axUS, facUS did not improve the overall diagnostic yield of ultrasound in the overall cohort as well as in the subgroup of patients presenting with permanent visual impairment. While lacking sensitivity, a cut-off ≥1.0 mm (maximum of both sides) was highly specific for a final diagnosis of GCA.

In a retrospective cohort study, the facial arteries were investigated in 82 of 230 patients and were found to be affected in almost half of the patients (n=40), all of whom experienced cranial symptoms. Only a single patient with a negative tempUS-study had a positive facUS-study (18). In the prospective EUREKA study, addition of facUS slightly increased the sensitivity of the ultrasound protocol (from 90% to 94%). In that study bilateral facial artery vasculitis was detected while tempUS was negative in two patients with cranial GCA (20). Likewise, another study found isolated facial artery involvement by colour duplex sonography in 3 of 93 patients with GCA (17). Noteworthy, in a reliability study, facUS (either detection of the Halo sign or of the compression sign) had excellent interobserver agreement (96% and 97%, respectively) (21).

Aiming at quantitative measurements, a case-control study found a cut-off value of ≥0.41 mm to have a surprisingly high sensitivity and specificity of 99.2% and 96.6% for diagnosis of GCA (19). Schäfer *et al*. reported a sensitivity and specificity of facUS with a cut-off of 0.37 mm of 87.5% and 98.5% (12). It must be that both studies relied on far wall IMT measurements, while the method of hrCS applied in our study measures both walls together, resulting in cut-off-values roughly twice as high as the single wall measurements. Both methods have been shown to be sensitive to change during follow-up-examinations (22, 23).

It must be taken into account, that arteriosclerotic changes may affect IMT-measurements of the facial arteries more frequently than those of the temporal arteries (24, 25). This may, at least in part, explain the limited diagnostic accuracy of facUS found in the present study (25% of patients with alternative diagnoses exhibited facUS ≥0.7 mm). The obvious discrepancy of diagnostic accuracy between our study and those mentioned above may be further related to the study methodology (case-control-studies *vs*. cohort study). A substantial proportion of our study cohort (69 out of 149 patients with complete imaging data) did not undergo facUS. As these patients were excluded from analysis, a selection bias (verification or spectrum bias) must be mentioned as the most important limitation of our study together with the retrospective data collection. In view of this potential selection bias, our results should be regarded as hypothesis-generating; a prospective study that includes analysis of the additional diagnostic yield of facUS in suspected GCA is ongoing. Another limitation is the small sample size of the sub-analysis of patients with permanent visual loss.

In conclusion, the addition of facUS does not notably improve the diagnostic accuracy of established ultrasound protocols for suspected GCA. Addition of facUS may be considered in selected patients with a substantiated clinical suspicion of cranial GCA but a negative tempUS-study. Bilateral wall thickening and wall thickening ≥1.0 mm are indicative of GCA in these patients.

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