Ultrasound assessment of the Gantzer muscle and its role in median nerve compression: a clinical and anatomical study

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SUMMARY

The Gantzer muscle (GM), an accessory head of the flexor pollicis longus (FPL), is a common anatomical variant with potential clinical relevance, due to its proximity to the median nerve (MN). While cadaveric studies report high prevalence, in vivo functional data remain limited. This study aimed to investigate the prevalence, morphology, and functional role of the GM in relation to median nerve morphology using high-resolution ultrasound.

A cross-sectional study was conducted on 51 healthy adults. Participants underwent standardized clinical screening to exclude pre-existing neuropathies. Bilateral forearm ultrasound examinations were performed at rest and during fist formation. GM thickness and MN cross-sectional area were measured, and associations with sex, ethnicity, and body mass index were analysed. Correlation and regression analyses were applied to assess the relationship between GM and MN morphology. The GM was identified in 62.7% of participants, with slightly higher prevalence in the right forearm (74.5%) compared to the left (70.4%). Prevalence did not differ significantly across sex or ethnicity. No significant differences in GM or MN thickness were observed between rest and contraction. However, on the left side, GM thickness at rest correlated positively with MN thickness ($r = 0.29$, $p = 0.042$). A significant inverse correlation was found between changes in GM and MN thickness during contraction ($r = –0.46$, $p < 0.001$), suggesting transient compression.

The GM is a frequent anatomical variant that does not alter baseline MN morphology but may influence nerve dimensions dynamically. These findings highlight the clinical importance of dynamic ultrasound in evaluating potential mechanisms of intermittent median nerve compression.

Key words: Gantzer muscle – Accessory head of flexor pollicis longus – Ultrasound – Median nerve – Entrapment neuropathy – Anatomical variation – Dynamic imaging

INTRODUCTION

The Gantzer's muscle is a forearm variant arising from the FDS and inserting into the tendon of flexor pollicis longus (FPL) or rarely flexor digitorum profundus (FDP) (Celuck et al., 2018). It is

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most commonly derived from the FDS or common flexor origin at the medial epicondyle of the humerus (Asghar et al., 2022). Previous cadaveric anatomic studies have described the muscle to be present in mostly 50-68% of forearms (Caetano et al., 2015). This muscle was categorized in 97% of cases an accessory head to FPL, and 3% to FDP (Oliveira et al., 2022). Although this supernumerary muscle is usually asymptomatic, due to its close anatomic proximity from the median nerve, there are worries that it may be one of the determinant factors implicated in compressive neuropathies (Caetano et al., 2015).

Compression of the median nerve is among the most common mononeuropathies encountered in clinical practice, and entrapment at sites such as the carpal tunnel, pronator teres, or the ligament of Struthers have all been reported (Binsaleem, 2025). Yet, the contribution of the Gantzer muscle as an entrapment site has been under-reported. The overwhelming majority of evidence is based on cadaver dissections that, while useful for anatomical description, cannot simulate the dynamic interaction between the muscle and nerve, the latter of which may be subjected to various mechanical stimuli.

Recent studies attempting to bridge this gap have been based on imaging methods. For example, Torun and Balaban (2022) found that the prevalence of a well-developed muscle was about 22%, much lower than in cadavers, possibly because of methodological limitations or misdiagnosis. Imaging methods such as MRI and ultrasound (US) have been used to visualise the Gantzer muscle and its proximity to the median and anterior interosseous nerves (al-Qattan, 1996; Torun and Balaban, 2022). However, most studies focused on morphology rather than function, and dynamic US assessments exploring its compressive effect on the median nerve remain scarce (Caetano et al., 2015; Kuo et al., 2016). Therefore, the functional and clinical relevance of this anatomic variation is uncertain.

In view of this knowledge gap, the current study evaluates the prevalence, characteristic morphology, and dynamic behaviour of Gantzer' s muscle using high-resolution ultrasonography. In particular, we have attempted to investigate the way in which changes in Gantzer muscle thickness at rest or during contraction might be related to median nerve morphology and to explore any potential relationship with demographic variables such as sex and ethnicity. By presenting non-cadaveric, functional data, this study adds to our understanding of the Gantzer muscle, which is hypothesised to play a role in median nerve compression.

MATERIALS AND METHODS

Study design and setting

This was a cross-sectional, observational, and analytical study conducted at St. George's University (SGU). The study received ethical approval from the Northumbria University Ethical Review Board (Project number 7087).

Participants

A total of 51 subjects were included; they had been selected according to normative criteria. In the inclusion criteria, participants were to be adults 18 years and older, with no history of upper limb trauma, surgery and congenital malformations and willingness to consent to the study. Exclusion criteria comprised clinical signs of median nerve compression, known neuromuscular upper limb dysfunction, recent (within 6 months) or current history of forearm or hand injury and gravidity (to eliminate pregnancy-induced soft tissue alterations). Basic demographic information such as age, gender, ethnicity and body mass index (BMI) was obtained.

Clinical screening for nerve compression

Before ultrasonographic examination, subjects were clinically screened for pre-existing median nerve compression. This entailed Tinel's sign (tapping over the median nerve and provoking tingling, pain), Phalen's manoeuvre (wrist flexion for 60 s provoking paraesthesia), resisted forearm pronation test (detecting proximal entrapment compatible with pronator syndrome) and anterior interosseous nerve functional test (inability to make a proper "OK" sign indicating AIN involvement) (Löppönen et al., 2022) (Fig. 1). All participants with evidence of presence were excluded.

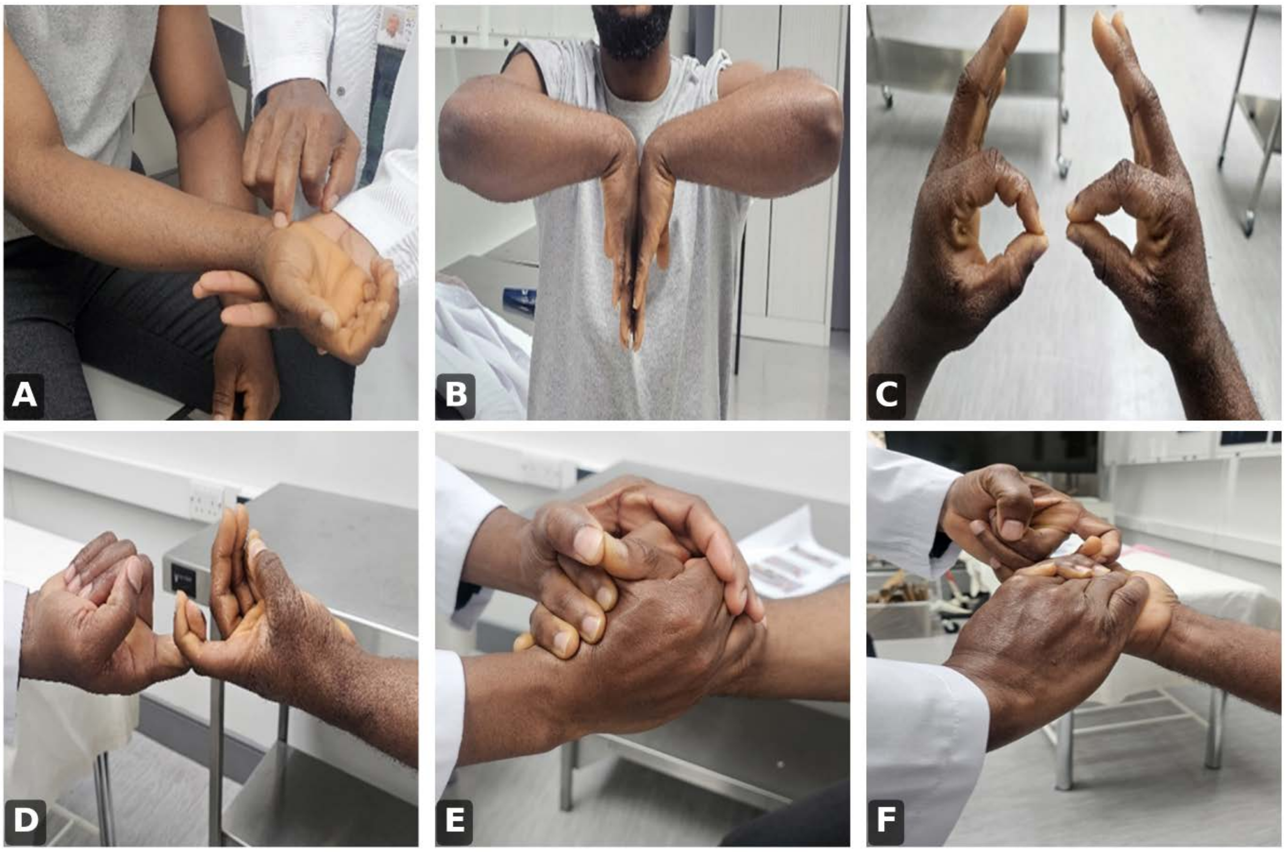

Fig. 1.- Clinical screening tests used to exclude participants with pre-existing median nerve compression prior to ultrasound examination. (A) Tinel's sign – percussion over the median nerve at the wrist to elicit paraesthesia. (B) Phalen's manoeuvre – sustained wrist flexion for 60 seconds to provoke tingling or numbness. (C) Anterior interosseous nerve (AIN) functional test – assessment of the ability to form a proper "OK" sign; failure indicates AIN involvement. (E–F) Resisted forearm pronation test – resistance applied against pronation to reproduce symptoms consistent with pronator syndrome.

Ultrasound examination

Ultrasound Study: The high-quality ultrasound scan was performed using a GE LOGIQ ultrasound system equipped with a high-frequency 15–18 MHz linear transducer. Specific anatomical landmarks such as the flexor digitorum superficialis (FDS), the flexor pollicis longus (traditionally in rest and during fist development to compare the dynamics. Gantzer muscle thickness and cross-sectional area of the median nerve were evaluated in both positions (Fig. 2). FPL), the median nerve (MN), the ulnar artery (UA), and the ulnar vein (UV) were identified to also accurately determine the localization. Measurements were taken at the proximal third of the forearm, midway between the medial epicondyle and the radial styloid process. The Gantzer muscle thickness was defined as the maximum vertical diameter in the axial (transverse) plane, while the cross-sectional area of the median nerve was measured at the same level. All measurements were recorded in millimetres (mm). Each measurement was repeated three times, and the mean value was used for analysis in order to minimize intra-observer variability.

Statistical analysis

All analyses were conducted using IBM SPSS Statistics (Version XX). Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. The Shapir-Wilk test was applied to assess normality of continuous data. Parametric or non-parametric tests were selected accordingly.

The prevalence of the Gantzer muscle (GM) was calculated at both participant and limb levels, and comparisons by sex and ethnicity were performed using the chi-square test.

To evaluate differences in GM and median nerve (MN) thickness between rest and contraction, paired-samples t-tests (or Wilcoxon signed-rank

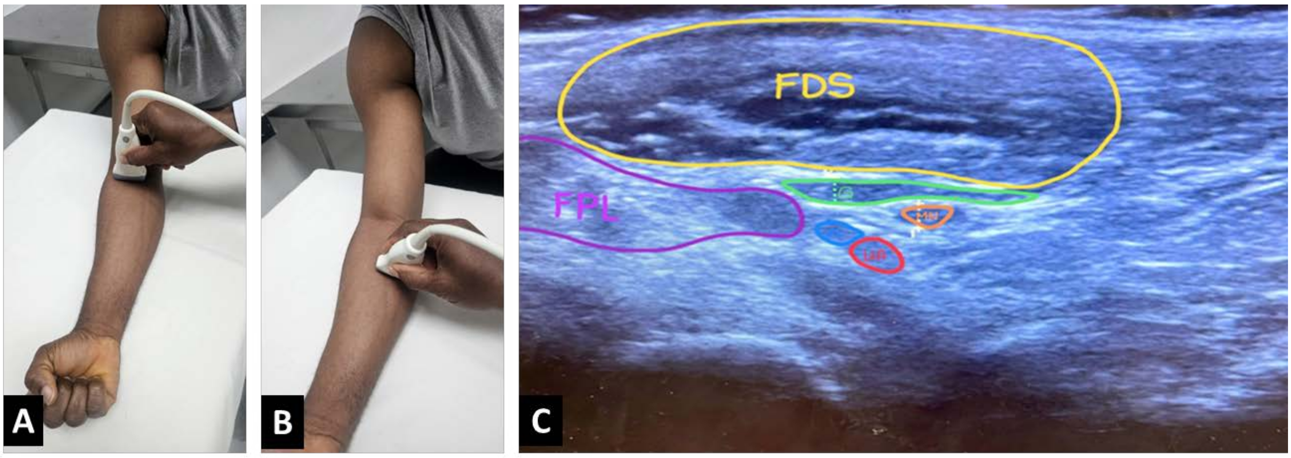

Fig. 2.- Ultrasound examination of Gantzer's muscle (GM). (A) Probe positioning during active finger flexion to assess dynamic changes. (B) Probe positioning with the forearm at Rest. (C) Annotated ultrasound image demonstrating relevant anatomical structures: flexor digitorum superficialis (FDS), flexor pollicis longus (FPL), Gantzer's muscle (G/GM), median nerve (MN), ulnar vein (UV), and ulnar artery (UA).

tests where assumptions were violated) were applied. The effect of GM presence on MN thickness was analysed using independent-samples t-tests (or Mann–Whitney U tests as appropriate).

Correlation analyses were performed to examine the relationship between GM and MN thickness at rest, contraction, and the change (Δ rest to contraction), using Pearson's correlation for normally distributed data and Spearman's rho otherwise.

Finally, multiple linear regression analyses were conducted to explore whether GM presence, sex, ethnicity, age, or BMI independently predicted MN thickness.

To ensure measurement reliability, each ultrasound measurement was obtained multiple times per participant, and the average value was used for analysis to minimize intra-observer variability. Inter-observer variability was not applicable, as all examinations were conducted by the same experienced investigator following a standardized protocol. A p-value < 0.05 was considered statistically significant.

RESULTS

Study population

51 volunteers were enrolled in the study. The average age was 22.0 ± 5.2 years (range, 18–52 years). The average BMI was 23.1 ± 3.9 kg/m² (range 16.0 to 34.0 kg/m²). Regarding sex ratio, 28 (54.9%) female and 22 (43.1%) were male, and 1 (2.0%) declined to report their sex. Ethnicity was heterogeneous: 17 subjects (33.3%) were from Eastern/North, 15 (29.4%) Asian, 9 (17.6%) European, 8 (15.7%) African, and 2 (3.9%) Hispanic / Latin.

Prevalence of the Gantzer muscle

The Gantzer muscle was present in 32 out of 51 subjects (62.7%). The limb level prevalence was 74.5% in the right forearm, 70.4% in the left forearm, and 19.6% bilateral involvement. This means that Gantzer muscle was seen slightly more on the right side rather than the left.

There were no significant sex differences observed in prevalence when compared between male and female ($X^2 = 0.75$, $p = 0.688$). No differences between groups were found regarding prevalence after comparing to the prevalence among

Table 1. Comparison of Gantzer muscle and median nerve thickness at rest versus contraction

Side	Tissue	Rest (Mean ± SD)	Contraction (Mean ± SD)	t-value	p-value	Significance
Right	Gantzer muscle	0.165 ± 0.113	0.166 ± 0.113	–0.14	0.888	NS
Right	Median nerve	0.150 ± 0.031	0.151 ± 0.037	–0.13	0.901	NS
Left	Gantzer muscle	0.155 ± 0.121	0.155 ± 0.118	0.02	0.984	NS
Left	Median nerve	0.148 ± 0.038	0.142 ± 0.045	1.67	0.101	NS (trend)

Table 2. Effect of Gantzer muscle presence on median nerve thickness

Side	GM Present (Mean ± SD, mm)	GM Absent (Mean ± SD, mm)	t-value	p-value	Significance
Right MN	0.160 ± 0.036	0.147 ± 0.029	1.12	0.280	NS
Left MN	0.152 ± 0.035	0.146 ± 0.040	0.55	0.588	NS

the reference standard ($X^2 = 3.36$, p = 0.499) or when comparing between ethnic groups (European - African - Asian - Eastern/North - Hispanic/Latin).

Gantzer muscle and nerve thickness at rest vs. contraction

There were no statistically significant differences in GM or MN thickness at rest and contraction on both sides (Table 1). The mean right and left GM thickness were unchanged between conditions. There was also no shift in median nerve thickness; however, a tendency (P = 0.101) for decreased thickness was detected in the left MN during contraction.

Effect of Gantzer muscle presence on median nerve thickness

The presence of the Gantzer muscle did not have a statistically significant impact on the thickness of the MN on both the sides (Table 2). On the right, the MN thickness was a little thicker in the Gantzer muscle group (0.160 ± 0.036 mm) in comparison with that in the non-Gantzer muscle group (0.147 ± 0.029 mm), but the difference had no statistical significance (t = 1.12, p = 0.280). Similarly, on the left side, MN thickness was slightly increased in GM-present (0.152 ± 0.035 mm) compared to GM-absent (0.146 ± 0.040 mm) group; however, the difference was also not significant (t = 0.55, p = 0.588).

Correlation between Gantzer muscle and median nerve thickness

Correlation analysis was performed to investigate whether the change in GM thickness correlated with the change in MN thickness during this process which could reflect the mechanism of dynamic nerve compression. The results were side-dependent (Table 3). A weak positive correlation was observed between GM thickness at rest and MN thickness on left side (r = 0.29, p = 0.042). There was no correlation between GM thickness and MN thickness during contraction (r = 0.18, p = 0.201). The inverse correlation was somewhat low, but highly significant, with r = –0.46, p < 0.001, while evaluating the difference of thickness from rest to contraction (Δ), indicating that thicker GMs, during contraction, showed thinner MNs, resembling the gradient of compression or displacement. Correlations were all weak and non-significant on the right, with a small negative trend for Δ (r = –0.23, p = 0.099).

Predictors of median nerve thickness

Regression analysis was conducted to determine whether sex, ethnicity, age, BMI or the presence of the GM could predict MN thickness. The VE measures predicted neither right nor left MN thickness significantly (all p > 0.05). Despite some positive coefficients of sex, indicating some increase in nerve thickness in males compared to in females, this tendency was quite weak and could not be supported by statistical means here. There was also a slight negative tendency between age and right MN thickness (ß = –0.002, p = 0.074), though it did not reach the significant level. In general, the models accounted for very little variance in MN thickness (Right MN: Adjusted $R^2 = 0.003$; Left MN: Adjusted $R^2 = -0.069$), suggesting that the predictors entered in this analysis only poorly explain adaptations in MN morphology. These results imply that other anatomical or physiological parameters that were integrated into our simple model are probably less responsible for MN variability (Table 4).

DISCUSSION

Using high-resolution ultrasonography, this study determined the frequency, morphology, and functional relevance of the Gantzer muscle (GM) with respect to the median nerve (MN) in healthy adults. We sought to determine whether this accessory muscle can be involved in morpho-

Table 3. Correlation between Gantzer muscle and median nerve thickness

Condition	n	r-value	95% CI	p-value	Strength	Significance
Right Rest	51	0.07	–0.21 to 0.34	0.630	Very weak	NS
Right Contraction	51	0.20	–0.08 to 0.45	0.159	Weak	NS
Left Rest	51	0.29	0.01 to 0.52	0.042	Weak	Significant
Left Contraction	51	0.18	–0.10 to 0.44	0.201	Very weak	NS
Right Δ (Rest→Flex)	51	–0.23	–0.48 to 0.05	0.099	Weak	NS
Left Δ (Rest→Flex)	51	–0.46	–0.65 to –0.21	0.001	Moderate	Significant

Table 4. Regression analysis of predictors of median nerve thickness

Predictor	ß Coefficient	SE	t-value	95% CI	p-value	Interpretation
GM presence	0.004	0.009	0.43	–0.014 to 0.022	0.668	No effect
Gender	0.007	0.008	0.95	–0.008 to 0.023	0.347	No effect
Ethnicity	–0.004	0.004	–0.91	–0.012 to 0.004	0.367	No effect
Age	–0.002	0.001	–1.83	–0.003 to 0.000	0.074	Negative trend
BMI	0.001	0.001	0.80	–0.001 to 0.003	0.428	No effect

logical variability of the MN by investigating it in vivo, and to contribute to the interpretation from previous cadaveric studies by evaluating it both at rest and with force generation. This study identified the Gantzer muscle (GM) in 62.7% of healthy adults using dynamic ultrasonography. The presence of the GM did not significantly alter baseline median nerve (MN) morphology; however, on the left side, a negative correlation between changes in GM and MN thickness during contraction ($r = –0.46$, $p < 0.001$) suggested a transient, side-dependent compression effect. Demographic and anthropometric variables did not independently predict MN thickness.

The GM was detected in 62.7% of the subjects, and the detection rate was marginally higher in the right forearm (74.5%) than in the left (70.4%). These findings are generally supported by previous cadaveric studies which have reported GM prevalence as 50–68% (Caetano et al., 2015; Asghar et al., 2022) and higher than ultrasound studies that have found cervical rib prevalence to be around 22–30% (Torun and Balaban, 2022). Our increased detection rate could be attributed to methodological variations, especially dynamic imaging while contracting, which might facilitate identification of this small muscle as opposed to static imaging. Prevalence did not vary significantly by sex or ethnicity, which was considered significant to the explanation of the GM as a frequent but essentially normal anatomical variant.

Our in-vivo prevalence aligns with previous cadaveric reports (50–68%) (Caetano et al., 2015; Oliveira et al., 2022; Asghar et al., 2022), and is higher than that reported in most imaging studies (Torun and Balaban, 2022). The discrepancy may reflect methodological differences: dynamic ultrasound allows real-time identification of a small accessory head, whereas static imaging particularly MRI may overlook a thin or partially fused GM. Differences in scanning landmarks, probe orientation, and operator expertise may also contribute to variation among studies. The lack of baseline MN morphological differences in our asymptomatic cohort suggests that the GM is a common anatomical variant whose effects on the nerve are functional and transient, rather than structural or constant, supporting a dynamic-compression hypothesis rather than fixed entrapment.

The present findings extend earlier US and MRI studies, which mainly described the presence and morphology of the GM without assessing movement-related effects (Torun and Balaban, 2022; Caetano et al., 2015). High-resolution ultrasonography, unlike MRI, enables direct visualisation of the GM and adjacent neurovascular structures during contraction, offering a unique opportunity to explore muscle–nerve dynamics. Our use of dynamic assessment provides novel evidence that contraction of the GM may transiently influence MN calibre, potentially explaining intermittent symptoms in certain individuals.

While the majority of evidence regarding Gantzer's muscle (GM) is derived from cadaveric studies, multiple clinical case reports illustrate neuropathy associated with GM in vivo. Tabib et al. characterised incomplete anterior interosseous nerve (AIN) syndrome, with isolated flexor pollicis longus palsy resulting from mechanical compression by Gantzer's muscle, with complete recovery after surgical decompression (Tabib et al., 2001). Degreef and De Smet (2004) documented AIN paralysis relieved by resection of a fibrous GM edge compressing the nerve at exploration. More recently, Musa et al. described AIN syndrome in which GM was identified both clinically and radiologically as the compressive substrate, coexisting with myasthenia gravis (Musa et al., 2021).

Furthermore, multiple case reports have documented median or anterior interosseous nerve (AIN) palsy associated with hypertrophic or anomalously inserted GMs (al-Qattan, 1996; Caetano et al., 2015; Zdilla et al., 2019). Taken together, these clinical observations support the biological plausibility that a hypertrophic or aberrantly coursing GM can produce symptomatic AIN/median neuropathy, complementing our ultrasound evidence of dynamic, transient calibre change in the median nerve during GM contraction.

Correlation analyses, however, showed side-dependent relationships. On the left, at rest and in contraction, GM thickness correlated positively with MN thickness at rest, and the change in thickness at rest and the change in thickness in contraction correlated negatively with a moderate or large effect size: greater thickening (>MN) was associated with more MN thinning. This indicates that GM does not result in a change in baseline nerve size but that its constriction potentially transiently affects MNs structures, supporting a mechanism of intermittent or activity-based compression (Zdilla et al., 2019; Caetano et al., 2015). On the right side, only a weak negative trend was shown but it was insignificant. This asymmetry could be due to genuine anthropological variation, handedness effects, an artefact of measurement, and requires exploration.

Independent-samples test results indicated that females had significantly thicker MNs compared with males on both sides, in agreement with previously reported differences in nerve dimensions with regard to sex and anthropometric parameters (Löppönen et al., 2022). However, sex was removed from the regression model when adjusted for other variables, and it did not contribute as an independent predictor. This inconsistency could be due to the small sample size, the overlap with other covariates (i.e., BMI or age) or to the fact that the model does not explain a large proportion of the variability (adjusted R^2 near to zero.). In sum, the current results indicate that, although sex differences in MN morphology exist, they are probably modulated by other anatomical or functional variables that need to be further explored.

The clinical significance of these findings lies in the dynamic relationship observed between GM contraction and MN thickness on the left side. While the GM was not an independent predictor of MN morphology, its activity-related changes may transiently alter MN dimensions, potentially contributing to compression in susceptible individuals. This supports longstanding hypotheses that the GM could play a contributory role in proximal median nerve entrapment syndromes. Although our study was conducted in asymptomatic participants, the results highlight the value of dynamic ultrasound in revealing subtle interactions that might not be captured in static imaging or cadaveric dissection.

Limitations and Future Directions

The sample size, although adequate for exploratory analysis, limited the power of subgroup comparisons across ethnic groups and BMI categories. The asymmetry between left and right sides may reflect true anatomical variation or unmeasured confounders such as handedness, which was not fully stratified. Moreover, while ultrasound provides valuable real-time functional imaging, it cannot directly measure intraneural pressure or mechanical stress. Unlike Torun and Balaban (2022), our study did not classify the positional relationship between the Gantzer muscle and the median nerve (anterior vs posterior course), which may influence the likelihood of compression. Future dynamic imaging studies should address this anatomical orientation. Larger multicentre studies incorporating both symptomatic and asymptomatic populations, as well as biomechanical modelling, would help clarify the contribution of the GM to clinical neuropathies.

CONCLUSION

This study confirms that the Gantzer muscle is a common anatomical variant, with a prevalence of over 60% in vivo. While its presence alone does not significantly alter median nerve morphology, dynamic ultrasound revealed that GM contraction may influence MN thickness in a side-specific manner, consistent with a potential mechanism of intermittent compression. These findings underscore the importance of considering the GM in the assessment of median nerve entrapment syndromes and highlight the need for further clinical and biomechanical research.

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