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THE INCIDENCE AND MORPHOLOGY OF THE GANTZER'S MUSCLE IN A KENYAN POPULATION

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ABSTRACT

Gantzer's muscle is an accessory head of the flexor pollicis longus (FPL). Its incidence, attachments as well as relations to nervous structures have been shown to exhibit population variations, which have important clinical bearings. Data from our setting however remains partly elucidated. To study the muscle, the skin of the anterior forearm and fascia were removed to expose the flexor compartment of the forearm. The flexor muscles were also identified and reflected. The Ganzter's muscle was identified as that muscle belly originating from the flexor digitorum superficialis, the radius, the medial humeral epicondyle or the ulna coronoid process and inserted on the flexor pollicis longus or the flexor digitorum superficialis muscle. Its prevalence, laterality, origin, insertion, shape and relation to the anterior interosseous nerve were determined. The data obtained was entered into SPSS and percentages calculated for the different variables. The muscle was found in 19/43 (44%) cadavers on the right and on 20/43 (46%) on the left. In 5 out the 43 cadavers (11%), the muscle was present bilaterally while in the rest, it existed solely as either on the right or left (predominantly on the left, 46%). The Gantzer's muscle was also noted to predominantly originate from the Flexor Digitorum Superficialis muscle (72% on the left, 76% on the right) and insert on the Flexor pollicis longus (100%). As regards its shape, it was predominantly triangular, on both right side (65%) as well as the left side (54%). In majority of the cases, the muscle also lay posterior to the anterior interosseous structures (100% on the left and 89% on the right). In conclusion, the Gantzer's muscle is relatively common in our population, exhibits marked population variations and as such should be taken into account especially during surgical approach to the anterior elbow to avoid its inadvertent injury.

Key words: gantzer's muscle, power grip, thumb stabilizer, precision handling, coronoid process
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INTRODUCTION

Gantzer's muscle is a muscle belly that has been regarded as an accessory head of the flexor pollicis longus (FPL). It joins FPL to the deep finger flexors (Caetano et al., 2015). Despite its existing literature, there is wide variability of its incidence as described by different authors, with a prevalence as high as 73.68% in the American population (Mangini, 1960) to as low as 0.5% in the Indian population (Sembian et al., 2012). Variations have also been reported in its laterality, relations to the anterior interosseous nerve and median nerves, on its origin as well as insertions and on its morphological appearance. Most of these variations have been shown to bear important clinical significance (Potu et al., 2007).

When present, the muscle has a variable relationship with anterior interosseous nerve. It has been shown to either lie anterior to the AIN (Shirali, 1998), or posterior (Dellon & Mackinnon, 1987; Al-Qattan, 1996). Owing to its relations to these structures, the gantzer's muscle has been linked to its possible compression with resulting clinical implications like anterior interosseous nerve syndrome (Kara et al., 2012; Potu et al., 2007; Bilecenoglu et al., 2005). In most cases, an anterior relation of the muscle to the anterior interosseous nerve has been linked more to compressions and resultant anterior interosseous nerve syndromes (Potu et al., 2007). Despite the low reported prevalence of AIN entrapment, data has suggested increased awareness of the condition by orthopaedic surgeons (Nagano et al., 2003). Therefore a study on the relation of the Gantzer's muscle to the AIN is paramount. Secondly, the location of the muscle as well as its spatial relation to the anterior interosseous nerve is of great importance when performing forearm dissections, ultrasound-guided nerve blocks, and imaging to avoid their inadvertent injury (Zdilla et al., 2019).

As concerns the origin of the muscle, studies have reported that it may arise from the Flexor digitorum superficialis (FDS), the radius, the medial humeral epicondyle or the ulna coronoid process (Potu et al., 2007). The most common insertion has been documented to be to the FPL or at times into the FDP.

The morphological shape of the muscle has also been reported to be variable, and this has a significant role in affecting the function and range of movements of the muscle (Levangie and Norkin, 2008; Sembian et al., 2012). The documented shapes are slender (Jones et al., 1997, spindle (Uyaroglu et al., 2006) and fusiform (El Domiaty et al., 2008; Pai et al., 2008; Kara et al., 2012; Caetano et al., 2015). The fusiform shape is thought to be most associated with risk of functional impairment since they are opposite to the unipennate fibres in the FPL and may result in excess strain to the muscle. Since the FPL acts as a thumb stabilizer, strain may result in reduction in power grip and precision handling.

In a meta-analysis done by Roy et al., 2015, the pooled geographical subgroups prevalence of the muscle were 44.9% in Asia, 50.3% in North America and 37.0% in Europe, suggesting an ethnic difference in the prevalence of this muscle. Consequently, within the African context, there is paucity of data, with previous works having been done in Egyptian population with a prevalence of 61.90% (El-Domiaty et al., 2008). Meta-analysis of pre-existing data on the variations of the ganzter's muscle has shown no difference based on sex and side.

Owing to the clinical significance and great variability in the anatomy of this muscle coupled with paucity of data in our regional setting, we aimed at describing the incidence and the morphology of the Gantzer's muscle within our population.

MATERIALS AND METHODS

The present study, a descriptive cross-sectional study of sample size 43, was performed at the Department of Human Anatomy, University of Nairobi. The formalin fixed specimens used were of adult Kenyan indigenous ethnicity. Ethical approval for use of cadaveric materials is provided for in the Kenyan Constitution. Any cadaver that had previous surgical operations or were missing either of the upper limbs was excluded from the study.

Prior to the collection of data, two longitudinal skin incisions were made. A lateral one running from the coracoid process to the base of the thumb and a medial one from the axilla to the base of the digiti minimi. The anterior skin flap and fascia were removed and the cubital fossa and the flexor compartment of the forearm exposed. The flexor muscles were then carefully separated and reflected to expose the gantzers muscle. It was identified as that muscle belly that originated from the Flexor digitorum superficialis (FDS), the radius, the medial humeral epicondyle or the ulna coronoid process and inserted on the FPL or the FDP. Its prevalence, laterality, origin, insertion, shape and relation to the AIN and median nerve were determined. The data was entered into SPSS and percentages obtained for the different variables. Data was presented in form of a table and representative images which highlighted the different variations noted.

RESULTS

Out of 43 cadaveric specimen, the ganzter's muscle was found in 19/43 (44%) cadavers on the right and 20/43 (46%) cadavers on the left. In 5 out the 43 cadavers (11%) dissected, the muscle was present in both limbs bilaterally while in the rest, it existed solely as either on the right or left (predominantly on the left).

Attachment of the Ganzter's muscle

The Gantzer's muscle was noted to predominantly originate from the Flexor Digitorum Superficialis muscle in 72% and 76% of the cadavers on the left and right respectively. In the remaining cases, it was noted to originate from the radius bone more than the coronoid process (Figures 1, 2, 3, 4). As regards its insertion, the muscle was noted to insert on the Flexor pollicis longus in all the cases that were observed (100%) on the right and left (Figure 5).

Morphology

The Gantzer's muscle was noted to have 3 different morphological types: triangular, spindle and slender types of morphology. Out of the 3 types, the muscle was noted to be mostly triangular on the right side (65%) as well as the left side (54%). On the remaining cases, it was noted to be more spindle shaped than slender on both the left and right sides (Figure 1, 5, 6, 7).

Relation to the anterior interosseous structures

When related to the anterior interosseous structures, the muscle was noted to lie either anterior or posterior to them. In our case, it was observed that on the right and left sides, the muscle lay predominantly posterior to the anterior interosseous structures (100% on the left and 89% on the right). In the remaining cases on the right side, it lay anterior (11%) to the anterior interosseous structures (Figure 1).

The origin, insertion, morphological types as well as relations are summarized. (Table 1).

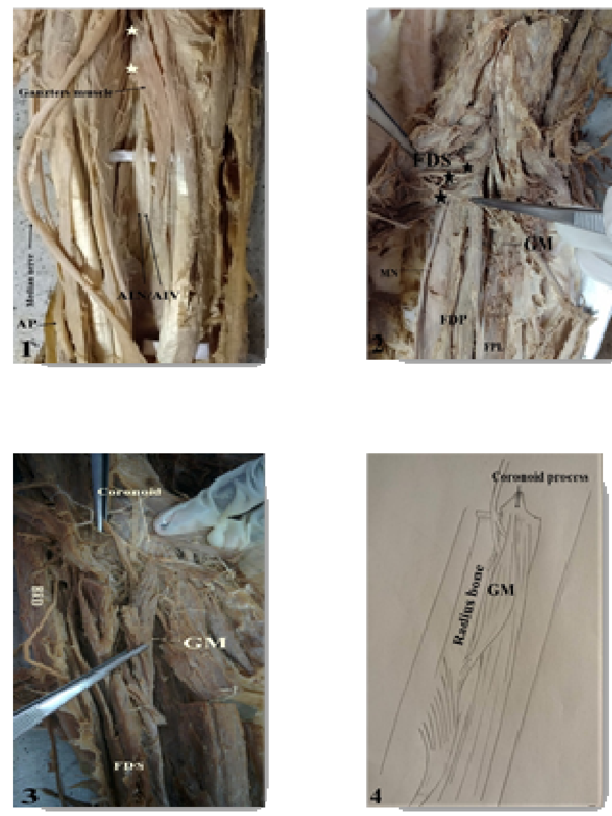
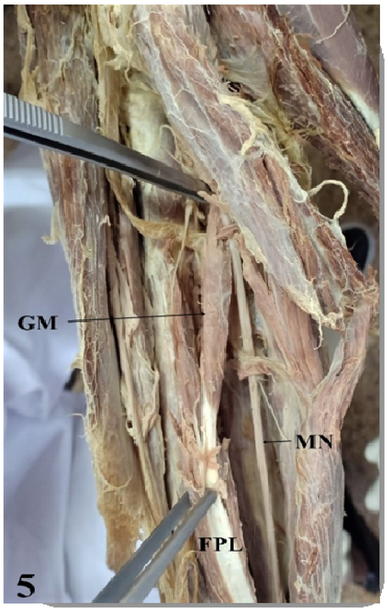
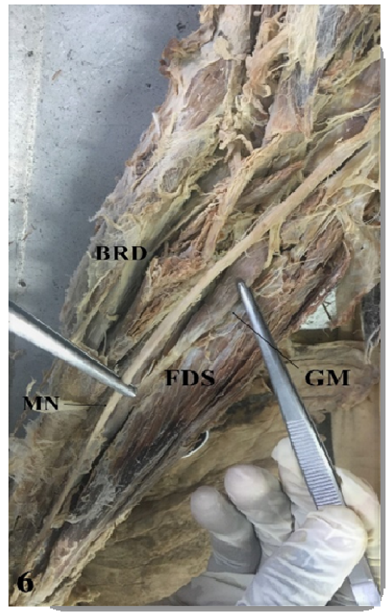
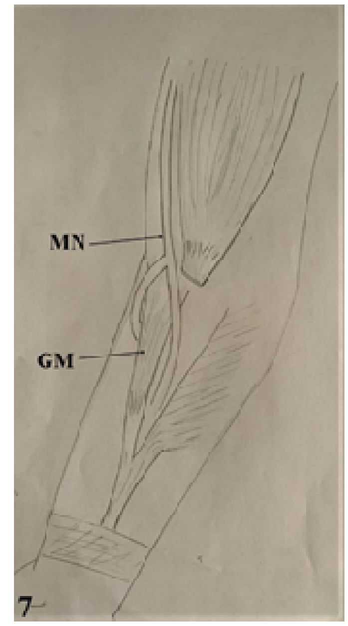


Figure showing (1): origin of the Gantzer's muscle (GM) from the radius bone (star shapes). Additionally note the posterior relation of the anterior interosseous neurovascular structures (AIN/AIV) to the GM. AP – Adductor pollicis. Note also, the spindle shape of the muscle. (2): origin of the Gantzer's muscle (GM) from the Flexor digitorum superficialis (FDS – note the star shapes indicating muscle fibres joining the two muscles). FDP – Flexor digitorum profunda; MN – Median nerve; FPL – flexor pollicis longus. (3): origin of the Gantzer's muscle from the coronoid process. GM – Gantzer's muscle; BRD – Brachioradialis. (4): Diagrammatic representation showing the origin of the Gantzer's muscle (GM) from the coronoid process.







Figures showing (5): the attachment of the Gantzer's muscle (GM) to the flexor pollicis longus (FPL). Additionally, note the median nerve (MN) and the slender shape of the GM. (6): the triangular shape of the Gantzer's muscle (GM). FDS- Flexor digitorum superficialis; MN – Median nerve, BRD – Brachioradialis. (7): Diagrammatic representation showing the triangular shape of the Gantzer's muscle (GM); MN – Median nerve.

Table 1: Table showing the results of the origin, insertion, morphological types as well as relations of the Gantzer's muscle.

	Left				Right			
Origin	26% from the radius	72% from the Flexor Digitorum Superficialis		2% from the coronoid process	22% from the radius	76% from the Flexor Digitorum Superficialis		2% from the coronoid process
Insertion	100% on the Flexor Pollicis Longus				100% on the Flexor Pollicis Longus			
Morphology	65% triangular shaped	13% slender Shaped	22% spindle shaped		54% triangular shaped	19% slender shaped	27% spindle shaped	
Relation to anterior interosseous structures	100 % posterior				89% posterior	11% anterior		

DISCUSSION

The Ganzter's muscle was noted in the 45% of the cadavers dissected in our population. This was lower than reported in previous studies in different populations (Mangini, 1960; Mahakkanukrauh et al., 2004; El-Domiaty et al., 2008; Caetano et al., 2015). The prevalence was comparable to that of the Indian population (Pai et al., 2008), English population (Jones et al., 1997) and the Turkish population (Kara et al., 2012). The prevalence was however higher than that reported by Sembian et al (2012) in an Indian population, Riveros et al (2015) in a Brazilian population and Tubbs et al (2006) in an American population.

Gantzer's muscle is postulated to arise as a result of incomplete cleavage of the flexor mass of the forearm during the 4th week of embryonic development. (Mahakkanukrauh et al., 2004; Jones et al., 1997). The wide range of its prevalence in different populations could be attributed to racial factors or could be as a result of the fusion of the muscle with adjacent muscles and hence misidentification and under-reporting of its prevalence (Bilecenoglu & Karalezli., 2005). The Gantzer's muscle should be borne in mind when dealing with deformities in the forearm and hand as it is postulated to be a contributing factor to compression neuropathies of the median nerve and AIN, with resultant important clinical implications. Thus, the clinician should bear in mind the Gantzer's muscle in patients presenting with symptoms of AIN syndrome or median nerve compression. Additionally, a case of long` standing flexion-contracture of the 1st interphalangeal joint secondary to an elbow fracture was attributed to scarring contracture of the Gantzer's muscle, and elongation of the muscle corrected the deformity. Consideration should also be given to the Gantzer's muscle when using anterior surgical approach to the proximal radius and elbow joints and when performing forearm decompression fasciotomies to relieve compartment syndrome. This is important to avoid iatrogenic injuries (Hemmady et al., 1993).

Of marked importance from our data is that the muscle existed predominantly on the right or left solely (89%). This result was quite different from data in India where the muscle existed bilaterally (Potu et al., 2007). Similarly, this could be attributed to racial factors that drive the embryological development of the muscle (Bilecenoglu & Karalezli., 2005).

In our setting, the muscle originated predominantly from the FDS and inserted majorly in the FPL. Regarding its origin, our findings sharply contrasted those derived from a meta-analysis done on the same, where the muscle was noted to originate predominantly from the medial condyle of the humerus in most cases (43.6) while originating from the FDS in only 0.7% of the cases studied. As regards insertion, the muscle, in our setting, mostly attached on the FPL. Unlike the contrasting data obtained for the origin, the findings of the insertion of Ganzters muscle was similar to those from other setting according to pooled data (Roy et al., 2015). The difference noted could be attributed to a difference in racial factors that might govern the different embryological origins as noted.

As regards the relation of the Gantzer's muscle to the nerves, it was noted to exist predominantly posterior to the anterior interosseous nerve in our study. This is comparable to the findings by Caetano et al., 2015 (Brazilian population) and Kara et al., 2012 (Turkish population). Our finding however, varied to that obtained in the American, Asians, Egyptian and Indian populations where the muscle was predominantly anterior to the nerves (Oh et al., 1988; Shirali et al., 1998; El Domiaty et al., 2008; Pai et al., 2008). The topographical relationship between the muscle and anterior interosseous nerve is thought to contribute to the occurrence of AIN syndrome, with the syndrome likely to occur in the cases in which the Gantzer's muscle lies anterior to the AIN (Mahakkanukrauh et al., 2004). With the muscle predominantly posterior to the anterior interosseous nerve in our population, it is very unlikely to cause AIN syndrome in our setting.

In our study, the muscle was predominantly triangular. This is in contrast to most other studies in which the shape was predominantly fusiform (El Domiaty et al., 2008; Pai et al., 2008; Kara et al., 2012; Caetano et al., 2015). Jones et al (1997) reported a predominance of slender shapes whereas Uyaroglu et al., 2006 found the spindle shape to be the most common. The fusiform shape is thought to be most associated with risk of functional impairment. This is because the fusiform fibres in Gantzer's muscle are opposite to the unipennate fibres in the FPL, resulting in excess strain to the muscle. Since the FPL acts as a thumb stabilizer in power grip and precision handling, such precise movements could be impaired with the presence of a fusiform Gantzer's muscle. (Levangie & Norkin., 2008; Sembian et al., 2012).

Conclusion

The Gantzer's muscle is relatively common in our population and exhibits marked difference especially as regards origin and lateralism. As such, its variations in our setting should be taken into account when dealing with forearm deformities and during surgical approach to the anterior elbow. It is however unlikely to cause anterior interosseous nerve syndrome in our setting, owing to its topographical relationship to the anterior interosseous nerve.

Limitation: The study employed a small sample size due to the lack of cadavers. We would like to replicate the study on a larger sample size if possible.

Conflict of interest: One of the authors serves as the managing editor for the journal. Review of this manuscript was however blinded from the author.

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