

Original articles

The arcade of Fröhse : an anatomic study

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Summary: An anatomic study of the appearance and consistency of the upper arcade of the superficial layer of the supinator m. was carried out on 106 elbow-joint dissections. A classification of the structure was drawn up in order to discern the criteria for normality. An arcade of a tendinous nature ("arcade of Fröhse") was encountered in the majority of cases (64.1%). At first sight, it could not be ascribed a compressive role affecting the posterior branch of the radial n. Macroscopic examination of the nerve prior to its entry under the supinator arcade revealed the presence of macroscopic lesions in 42.9% of cases. This high incidence does not permit any conclusions regarding the pathologic significance of this type of lesion.

L'arcade de Fröhse: étude anatomique

Résumé : Une étude anatomique de l'aspect et de la consistance de l'arcade supérieure du faisceau superficiel du m. supinateur a été réalisée sur 106 préparations de coudes. Une classification basée sur la structure a été établie afin de dégager des critères de normalité. Une arcade tendineuse ("arcade de

Fröhse") est rencontrée dans la majorité des cas (64.1%). On ne peut lui attribuer à priori un rôle de compression du rameau profond du n. radial. L'observation macroscopique du nerf avant son passage sous l'arcade du m. supinateur révèle la présence d'altérations macroscopiques dans 42.9% des cas. Cette incidence élevée ne nous permet pas de conclure à la signification pathologique de ce type d'altération.

Key words: Radial nerve — Arcade of Fröhse — Supinator — Tennis elbow

The upper edge of the superficial layer of the supinator m. is termed the "arcade of Fröhse" when this takes the form of a distinct tendinous arcade with distal convexity. Numerous authors have accorded it a pathologic role in certain types of paralysis of the deep branch of the radial n. [1, 2, 4, 5, 9, 10, 14, 18, 22, 23, 24]. Guillain and Courtellemont [15] were the first to postulate this hypothesis in 1905. According to other authors, epicondylalgia could well be an indication of compression of the deep branch of the radial n. where it passes between the two layers of the supinator [2, 3, 6, 7, 9, 12, 13, 16, 17, 19, 20, 21]. Roles and Maudsley [22] considered that the first symptom attending compression of this nerve by the

arcade of Fröhse is epicondylalgia, which can, as a secondary development, evolve into complete paralysis of the muscles innervated by this nerve. Spinner [24] carried out a complete study including the elbows of 50 adult and 10 full-term fetuses. He described the presence of a fibrous arcade in 30% of these cases and found a considerable degree of variation in the thickness of the arcade and in the space available for passage of the nerve. In 70% of the remaining cases, the arcade was of a membranous nature. He stressed that this arcade does not have any pathologic characteristics, but that it constitutes a factor likely to promote compression of the deep branch of the radial n. when pathologic changes occur at this level (inflammatory edema, tumor, etc.).

Amongst the 50 elbows operated by Hagert [16], the arcade of Fröhse seemed to be the only compressive factor acting on the deep branch of the radial n. and section of the arcade led to pain relief in the majority of cases. During the course of our dissections, we observed a certain degree of variation in the morphology of the superior arcade of the supinator m. We propose a classification of the appearance of this structure in order to specify the criteria for normality and to establish the distribution of the different morphologic aspects of the arcade.

Material and method

The dissections were carried out on both elbows of 53 embalmed cadavers (30 males, 23 females) from a random population of advanced age and white race. The exact age and handedness of the subjects is not known. Additionally, no information was available concerning the osteo-articular history, profession, habits and sporting activities of these subjects.

Careful dissection, layer by layer, of the elbow as well as the adjacent portions of the arm and forearm allowed access to the supinator m. as well as the deep branch of the radial n.

The morphologic aspect of the upper edge of the supinator m. was observed, particularly at the site of entry of the deep branch of the radial n. under the arcade.

The following classification was used:

- Type A: tendinous arcade: one formed by a layer of pearly-white fibers constituting a resistant arcade ("arcade of Fröhse").

- Type B: musculo-tendinous arcade: one formed by alternating tendinous and muscular fibers.

- Type C: muscular arcade: one whose nature resembled that of the rest of the muscle;

- Type D: membranous arcade: one presenting as a fine sheet of whitish tissue, supple and unorganised.

Subsequently, we examined the macroscopic appearance of the deep branch of the radial n. prior to its entry under the superficial layer of the supinator n., as well as in the tunnel formed by the muscle. Finally, we recorded the presence of anatomical variations in the supinator m. and in its relations with the deep branch of the radial n.

We did not study either the vascularisation or the histologic aspects of the radial n., since the embalming method did not allow satisfactory angiologic study or fixation suitable for microscopic examination.

Results

The arcade of the supinator m.

Figure 1 details the distribution of the various types of arcade observed at the

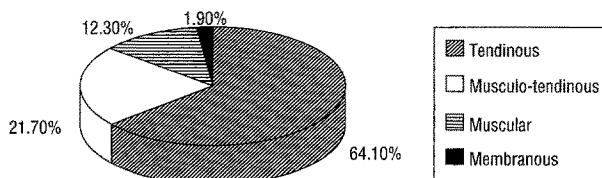


Fig. 1
Distribution of the different arcade types
Distribution des différents types d'arcades



Fig. 2
Tendinous arcade («arcade of Fröhse»)
Arcade tendineuse ("arcade de Fröhse")

Fig. 3
Musculotendinous arcade
Arcade musculo-tendineuse

level of the superficial layer of the supinator m. As no statistically significant difference (at a threshold of 5%) was found either between left and right elbows or between males and females, the group was studied as a whole. Observation of the superficial arcade of the supinator m. revealed the presence of an arcade of Fröhse in the majority of cases (64.1%) (Fig. 2). An intermediate structure of the musculo-tendinous type was observed in 21.7% of cases (Fig. 3), while a muscular edge

was encountered in only a few cases (12.3%). Only two dissections made in different individuals, presented an arcade of the membranous type (1.9%), so that an arcade of this type is a relatively rare feature.

The appearance of the nerve prior to its entrance under the superficial layer of the supinator m.

A macroscopic examination of the deep branch of the radial n. at the upper bor-

**Fig. 4**

Appearance of deep branch of radial n. before its passage under the superficial layer of the supinator m. (thickening and induration) and in the tunnel of the supinator m. (flattened appearance)

Aspect du rameau profond du n. radial avant son passage sous le faisceau superficiel du m. supinateur (épaississement et induration) et dans le canal du m. supinateur (aspect aplati)

Fig. 5

Anatomic variation of the supinator m.: duplication of the supinator arcade

Variation anatomique du m. supinateur: dédoublement de l'arcade du m. supinateur

Fig. 6

Anatomic variant of the supinator m. : emergence of the deep branch of the radial n. at the middle of the superficial layer of the supinator m.

Variation anatomique du m. supinateur : émergence du rameau profond du n. radial au milieu du faisceau superficiel du m. supinateur

der of the supinator m. was carried out in 84 anatomic specimens. The lesions were characterised by thickening and palpable induration of the nerve as compared with its proximal and distal portions (Fig. 4). Analysis of the results have not demonstrated any significant difference either between the left and right hand, nor between the two sexes. Thus, in the group as a whole, the total percentage of changes was 42.9%. (Table 1).

The appearance of the nerve in the tunnel of the supinator m.

Along its path in the tunnel within the supinator m., the deep branch of the radial n. always presents a flattened

appearance (Fig. 4). This is an anatomic feature, as classically described, which does not result from any compression of the nerve at this level.

Anatomic variations

In two dissections, we observed an anatomic variation in the supinator m. In one the deep branch of the radial n. emerged in the middle of the superficial layer of the supinator m. (Fig. 5). In the other, a well-marked tendinous band was separate from the main supinator arcade (Fig. 6).

Discussion

During its trajectory in the region of the elbow, the deep branch of the radial

Table 1. Macroscopic appearance of the deep branch of the radial n. prior to its entry under the superficial layer of the supinator m.

Aspect macroscopique du rameau profond du n. radial proximale à l'arcade du m. supinateur

	Lesion	No lesion	Total
Male	16	32	48
Female	20	16	36
Total	36 (42.9%)	48	84

n. seems particularly vulnerable at the superior edge of the superficial layer of the supinator m. Our results demonstrate that the supinator arcade is predominantly tendinous in nature (64.1%). This incidence is greater than that reported by Spinner (30%) [24]. The arcade appeared to be membranous in nature in 1.9% of cases, whereas Spinner reported this in 70% of his cases. These differences between our series and that of Spinner could well be explained either by a difference in the classification criteria, or by the fact that the two populations were not comparable. However, it should be noted that Spinner's classification included only two categories (tendinous and membranous arcades). Thus we cannot confirm the opinion given by Spinner.

One of the problems with this type of study is that the appearance of the arcade is described in a somewhat imprecise manner and this imprecision renders interpretation difficult. Amongst the 90 patients operated on by Werner [26], all of whom suffered pain at the point of entry of the deep branch of the radial n. under the supinator arcade, 80 of them presented a fibrous arcade (like type A) at the intersection with the nerve. His comparative study on cadavers gave similar results to those of our study since he demonstrated the presence of a fibrous arcade in 65% of cases.

Werner [26] found that, in cases with a fibrous arcade, the postoperative results were better than when the arcade was either muscular or membranous in nature. He concluded that the fibrous character of the arcade seems to constitute an important anatomic factor. Our study does not support any arguments

in favour of a lesion of the deep branch of the radial n. merely because an arcade of Fröhse is present. Nevertheless, it cannot be excluded that this arcade could promote damage to the nerve if a pathologic condition produces narrowing of the tunnel (inflammatory process, tumor, spasm, prolonged contraction of the supinator m., repetitive movements, etc.). In any case, compression of the nerve does not seem to be a common cause of epicondylalgia. The indication for systematic exploration of the supinator m. during the course of surgical intervention for epicondylalgia would not appear to be justified. On the contrary, an abnormal course of the deep branch of the radial n. might serve to explain any possible lesions and certain clinical symptoms.

Woltman and Learmonth [27] described a case of paralysis of the deep branch of the radial n. where the nerve did not pass between the two layers of the muscle but remained superficial, between the aponeurosis of the supinator m. and the extensor digitorum m. We cannot postulate any clinical expression of the two anatomic anomalies we encountered in the absence of any knowledge of the history of the subjects dissected.

On the other hand, various authors have observed macroscopic lesions of the deep branch of the radial n. at the level of the arcade of Fröhse. The study of Rosen and Werner [23], on 28 patients complaining of pain at the point of entrance of the nerve between the two layers of the supinator m. revealed that 8 presented groove marks on the nerve at its entry into the arcade as well as thickening proximal to this edge. Similar observations were made by Werner [26] in 17.8% of his cases. His comparative anatomic study on cadavers revealed a markedly smaller percentage of changes (6.7%). He considered that these changes could be produced by mechanical irritation of the nerve due to either static or intermittent compression. During the course of our dissections, we found that 42.9% of the nerves displayed changes at the level of the arcade of Fröhse, characterised by thickening and a palpable induration at this site. This high inci-

dence urges us to caution, since macroscopic changes in the nerve at the supinator arcade should not necessarily be regarded as pathognomonic. Unfortunately, the embalming techniques used on the cadavers did not allow us to carry out a histologic study of the nerve and the perineural structures which would have facilitated the detection of any anomalies.

Conclusion

This anatomic study allowed us to conclude that the superior arcade superficial layer of the supinator m. is of a tendinous nature in the majority of cases (64.1%). The presence of an arcade of Fröhse would appear to be consistent with normality. Nevertheless, it should not be excluded that an arcade of this type may be implicated in pathologic situations when a compressive factor is superimposed at this level.

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