J. Anat. (1992) 181, pp. 155–159, with 4 figures Printed in Great Britain

Short Report

Significance of the innervation pattern of the human abductor pollicis longus muscle

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(*Accepted 13 April 1992*)

ABSTRACT

The abductor pollicis longus muscle (APL) can be separated into 2 divisions, deep and superficial. The deep division has more bellies, each of which has its own site of insertion. The superficial division is situated on top of the deep tendon. Each division is innervated by a separate branch of the radial nerve. This pattern of innervation may indicate independent actions by individual muscle parts. The deep division, inserting around the carpometacarpal joint of the thumb, has a nerve supply that reaches each separate muscle belly. This division should have a stabilising action on the joint. The superficial division, together with the extensor pollicis brevis, is innervated from the ulnar side by a terminal branch of the radial nerve. This division should, in cooperation with the extensor pollicis brevis and longus muscles and the thenar muscles, act to move the thumb in various directions.

INTRODUCTION

The abductor pollicis longus (APL) has a complex structure. The conventional anatomical description is of a fusiform muscle covered proximally by the extensor digitorum and accompanied distally by the extensor pollicis brevis. Both are superficially located directly under the skin. The attachment of the APL is described as originating from the proximal part of the radius, the ulna and the interosseous membrane and inserting into the base of the 1st metacarpal bone (MC I). The muscle runs around the distal part of the radius from dorsal to ventrolateral and contributes to the muscular stabilisation of the carpometacarpal joint of the thumb. In an earlier study (Oudenaarde, 1991*a*), it was observed that the APL divides into deep and superficial divisions. The deep division originates in the proximal part of the forearm and inserts via 1 to 6 tendons around the 1st carpometacarpal joint. The course of the superficial division is more distal in the forearm and inserts into the MC I.

It is known that complex muscles, such as the APL, show a concomitant complex innervation pattern in keeping with the architecture of the muscle (Hollinshead & Markee, 1946; Sharrard, 1955; Schumacher et al. 1973; English & Letbetter, 1982; Simard & Roberge, 1988, Poliacu Prosé et al. 1989; Segal et al. 1991). The standard description of the nerve supply to the APL is from the posterior interosseus nerve, a terminal part of the motor division of the radial nerve. There has been no systematic description of the innervation of the individual parts of this muscle. The purpose of this study was to examine the relationship between the radial nerve and the divisions of the APL.

MATERIAL AND METHODS

A series of 84 formaldehyde-fixed right forearms was dissected, 22 of them with the aid of a dissecting microscope. The radial nerve was dissected in only 6 forearms. After removal of the skin, the radial nerve was traced into the forearm and its contribution to the separate divisions of the APL was analysed.

During dissection, the proximal attachments of the muscle were freed; the insertions were left intact. The

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Fig. 1. Branches of the radial nerve before penetrating into the supinator muscle. *S*, supinator muscle; *P*, proximal; *D*, distal; 1, radial nerve with 2 thin twigs; 2, early branch of the radial nerve; 3, final branch to the supinator.

architecture of the muscle bellies in the 2 divisions was explored and both divisions were separated. About 3–5 cm proximal to a transverse line running from the lateral to the medial epicondyles of the humerus, the radial nerve divides into 2 branches, superficial and deep. The superficial branch passes between the brachioradialis and the extensor carpi radialis longus and courses distally, making no contact with the APL. For this reason only the deep branch was dissected. During the dissection special attention was given to the terminal connections of the branches of the nerve to the separate parts of the muscle.

RESULTS

The radial nerve was found to innervate the muscles of the dorsal side of the forearm in a variety of ways. In one specimen, the following was found. From the main trunk, shortly before its penetration into the supinator, 4 smaller branches emerged (Fig. 1). The main trunk was accompanied by 2 slender branches. The other 2 separated from it and entered the supinator slightly more distally. One was the final branch to the supinator. In the other specimens there was a variable number of branches to the supinator.

A variable number of branches emerging from the supinator formed the posterior interosseus nerve. The main trunk was no longer identifiable as such. In each part of the muscle a separate branch of the nerve was found. Figure 2 shows the course of the 4 branches of specimen No. 1. The 1st was a final branch to the radial side of the proximal part of the APL. The 2nd passed obliquely over the APL without contact with the muscle and continued distally along the extensor pollicis longus muscle (EPL). This branch divided into 2 twigs to the ulnar side of the proximal part of the APL shortly after curving distally. After this it continued without side branches alongside the EPL and disappeared beneath the extensor retinaculum until it terminated. The 3rd gave off branches to the extensor digitorum muscle and then continued in the direction of the extensor carpi ulnaris muscle. The 4th was a thin branch. Initially it gave 2 twigs to the extensor digitorum; it then continued on the deep side of that muscle approximately 5–6 cm proximal to the wrist. At this point the branch terminated in the extensor indicis, the extensor pollicis brevis muscle and the superficial (ulnar and radial) part of the APL. Here the branch lay in network of blood vessels arising from the posterior interosseous artery and vein situated on the superficial part of the APL.

In the other specimens a different and variable pattern of nerve branches was found, but in all 6 forearms separate branches to each division of the APL could be identified. The 4th thin branch was identified in all specimens. In all cases a large number of branches to the extensor digitorum were present. By fine dissection it appeared that each separate belly had its own nerve supply (Fig. 3). Sometimes an additional branch to the superficial part of the muscle

Fig. 2. Branches of the radial nerve emerging from the supinator muscle. 1, final branch to the proximal radial side; 2, posterior interosseous nerve with branches to the ulnar proximal side; 3, branch with many twigs to the extensor digitorum muscle and the extensor carpi ulnaris; 4, final branch to the superficial division of the APL.

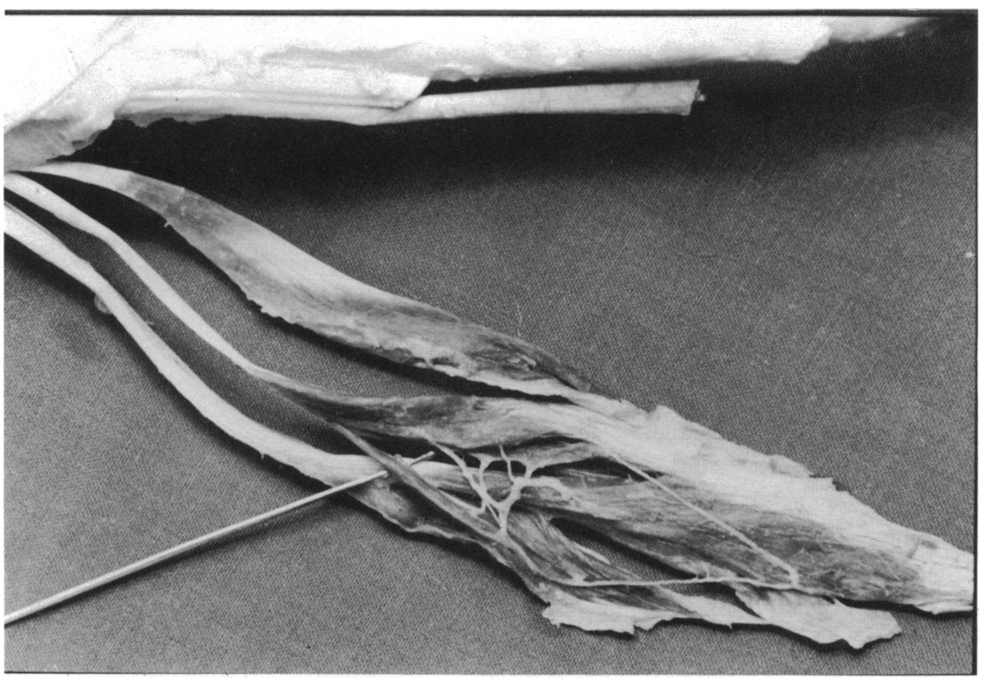

Fig. 3. Separate branches of the radial nerve to each belly of the APL.

was found on the radial side, so that there was an innervation both to the radial and the ulnar parts (Fig. 4).

DISCUSSION

The aim of this study was to determine the innervation to the separate divisions of the APL and to obtain more insight into its significance. It has been shown that each division of the APL has a separate branch from the radial nerve. During further dissection, a nerve branch to each muscle belly of the deep part of the APL was found.

In an earlier study (Oudenaarde, 1991*b*) it was noted that in all positions of the wrist, passive movements of the thumb cause movement of the

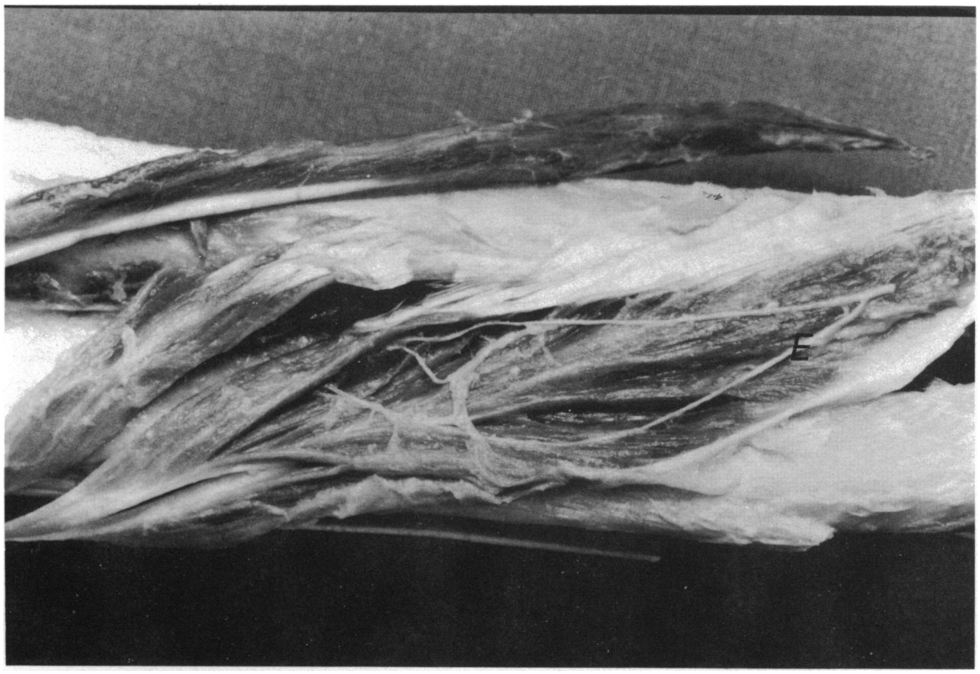

Fig. 4. An extra twig of the radial nerve on the radial side to the superficial division of the APL. *E*, extra twig.

superficial tendon only. In movements of the wrist both tendons are displaced simultaneously over almost equal distances. Based on observations on passive movements in cadavers, it has been suggested that both divisions of the APL function independently during movements of the thumb and cooperate during wrist activity. The innervation pattern confirms this view.

About half a century ago Markee & Löwenbach (1945) and Hollinshead & Markee (1946) reported this pattern of innervation for the muscles of the lower limb of the dog, such as the sartorius, rectus femoris and semimembranosus. Hollinshead & Markee noted that the majority of the muscles of the body have a multisegmental innervation. Most studies have been on the hindlimb. Although it is questionable whether these findings in animal (English & Letbetter, 1982; Weeks & English, 1985, 1986) and human legs (Schumacher et al. 1973; Gottschalk et al. 1989; Poliacu Prosé et al. 1989) are transferable to the innervation of the forearm muscles, this is likely (Leong et al. 1987; Fritz, et al. 1981; Segal et al. 1991). All authors mentioned that in complex muscles, with more than one function, divisions are distinguishable. A unique function may be assigned to each division, and each is supplied by at least one nerve branch.

Simard & Roberge (1988) described the innervation of the abductor pollicis brevis. This muscles shows a comparable construction to the APL in having several, divisions, each with a separate nerve supply. To each division there is at least one nerve branch, in this instance from the median nerve. They suggested that this pattern of innervation indicates functional independence of the various parts of the muscle.

In conclusion, it appears that a separate innervation to separate parts of a muscle is an indication of differing function of the parts. For the APL it is now believed that the divisions can be functionally independent, but more information is required. An EMG study has been initiated into thumb and wrist movement to assess the role of the 2 parts of the APL in movements of the thumb.

ACKNOWLEDGEMENTS

The authors are grateful to Professor Dr J. M. G. Kauer of the Department of Anatomy and Embryology, University of Nijmegen, for encouraging this project, supplying some of the material and providing hospitality in his laboratory.

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