A STUDY ON THE COURSE OF THE MESENCEPHALIC ROOT OF THE TRIGEMINAL NERVE AND SOME OF ITS RELATIONS IN THE CAT

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INTRODUCTION

The mesencephalic root of the trigeminal nerve has been previously investigated as regards its fibre constitution and its relation to neighbouring structures. The presence of collaterals from the root fibres as well as the axonal bifurcation of the mesencephalic nucleus cells have been described by Cajal (1896), Johnston (1909), Thelander (1942) and Kappers et al (1963). However, Cajal (1896) was the first to report that collaterals from the mesencephalic root travese to the motor cells of the trigeminal nerve. The anatomical relationship between the intrabulbar part of the trochlear nerve and the mesencephalic root was described in different animal species by Duval (1878), Obersteiner (1892), Hulles (1907) and Weinberg (1928).

Concerning the relationship between the mesencephalic root and the cerebellum, several investigations were available in the literature where various approaches were followed in different animals. The existance of fibres passing from the mesencephalic nucleus to the cerebellum was noticed by many authors in the frog, opossum, bat, cat and pigeons (Willems, 1911; Larsel, 1923; Voris and Hoerr, 1932; Pearson, 1949 b and Whillock, 1952). Acute retrograde degeneration in some mesencephalic cells was observed by Brodal and Saugstad (1965) who made lesions in various parts of the cerebellum of young kittens. Furthermore, Bortolami et al (1972) also recorded degenerative changes in the mesencephalic cells following interruption of the inferior cerebellar peduncle in ducks.

Johnston (1909) and Weinberg (1928) studied the relationship between the mesencephalic root and the optic tectum in some animals. Tarkhan (1934) reported that the rostral part of the mesencephalic root and the optic tectum in some

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animals. Tarkhan (1934) reported that the rostral part of the mesencephalic nucleus was intimately related to the tectospinal tract and assumed that the contribution from the mesencephalic root to the oculomotor nerve could be affected at this site.

The present work aims at providing more informations about the position and course of the mesencephalic root as well as its relations to the trochlear nerve, the brachium conjunctivum and the colliculotegmental fibres.

MATERIAL AND METHODS

The material used in this study consisted of 21 adult cats that were sacrificed after intraperitoneal injection of nembutal. The brain was removed and the brain stem was fixed and embedded in paraffin blocks. Serial sections were cut in coronal, sagittal and transverse planes. The sections were stained with Ramone y Cajal, Sand's method and Marsland's modification of gross Bielschowsky silver impregnation methods. The course of the mesencephalic root inside the brain stem and its relations to nearby structures especially the trochlear nerve fibres, the brachium conjuctivum and the colliculotegmental fibres were described.

RESULTS

The mesencephalic root is made up of neuraxes and dendritic processes of the mesencephalic cells. It is to be noted that although the cells of the mesencephalic nucleus reach to a level just caudal to the posterior commissure, the fibres of the root become apparent at some distance distal to the rostral limit of the nucleus. The mesencephalic root is found to be small and slender opposite the superior colliculus then increases gradually as it proceeds caudally by the addition of new fibres. At the superior colliculus the root has a more or less vertical course with a slight lateral convexity where it lies medial to the concavity of the tectospinal tract.

At the level of the inferior colliculus the mesencephalic root is closely applied to the inner aspect of the collicular grey matter. There is an increase in the size of the mesencephalic root due to further addition of axonal processes from mesencephalic cells scattered along its dorsal and ventral aspects.

In both coronal and transverse its maximal thickness opposite the level of the trochlear decussation in the anterior medullary velum, after which it remains more or less constant in size. Caudal to the level of the anterior medullary velum the mesencephalic root bends ventrally formaing an obtuse angle on itself and descends medial to the brachium conjuctivum.

In both coronal and transverse sections of the brain stem axonal processes of the large unipolar mesencephalic cells are seen to bifurcate at a variable distance from their perikarya. This axonal bifurcation is observed mainly opposite the level of the trochlear decussation. One of the two branches of each bifurcated axon continues through the mesencephalic root while the other proceeds towards the anterior medullary velum to join trochlear nerve bundles(fig. 1). Slender collaterals are seen to arise from the root fibres in the area between the trochlear and oculomotor nuclei. In addition, other fine collaterals travel within the mesencephalic root either in a cranial or caudal direction (fig. 2).

The mesencephalic root and the trochlear nerve :

The intrabulbar part of the trochlear nerve crosses the mesencephalic root just caudal to the inferior colliculus where it kinks the lateral aspect of the root forming an interlacing mass with its fibres. Opposite the anterior medullary velum a group of mesencephalic fibres appears to enter the velum with the trochlear nerve fibres which mix with those of the opposite side in the trochlear decussation (figs. 3 & 4).

The mesencephalic root and the brachium conjunctivum :

The fibres of the brachium conjunctivum are noticed to attain a ventrolateral position to the mesencephalic root in the upper part of the pons where the two groups of fibres are identifiable from each other. Fibres of the branchium conjunctivum sweep medially, ventrally and cranially towards the decussation in the inferior part of the midbrain. The lateral fibres of the mesencephalic root intermingle with the most medial fasciculi of the brachium where some of the mesencephalic cells are observed amidst them. By tracing the processes of these cells they are found to follow the same direction as that of the brachium (fig. 5.)

The meencephalic root and the colliculotegmental fibres :

Axons from some large cells of the optic tectum run in a separate group ventromedially around the central grey matter. These colliculotegmental fibres are usually thickly myelinated and have a relatively large caliber. They decussate in the dorsal tegmental decussation, intermingle with the medial longitudinal fasciculus and continue caudally as the tectospinal tracts. Few of these decussating fibres are found to reach the oculomotor nuclei where they join the fibres of the third cranial nerve. The mesencephalic cells and root keep a close medial relation to the colliculotegmental fibres with some of the cells observed among its bundles (fig. 6). Some of the mesencephalic cells send their processes to join the bundles of the tectospinal tract and pass along with them.

DISCUSSION

In this study the mesencephalic root fibres are noticed to give collateral branches which travel partly caudal and partly cranial in the brain stem. Caudally directed collaterals from the mesencephalic root have been previously reported by Cajal (1896). The presence of collaterals passing cranially may provide an anatomical substratum for a reflex arc between the ocular muscles and the trigeminal motor nucleus assumed by Sano (1959) as an explanation for his cases suffering from levator-pterygoid synkinesis.

The anatomical relationship between the colliculotegmental fibres and the mesencephalic root on one hand and the oculomotor and trochlear nerves on the other hand may provide a possible pathway along which proprioceptive impulses could reach the mesencephalic nucleus from the extraocular muscles. This is confirmed in the present work by the finding of contribution of fibres from the mesencephalic nucleus to the colliculotegmental tract and the tracing of fibres from the latter to the oculomotor nucleus and the trochlear nerve. Cooper et al (1951) were able to pick up impulses from both the rostral and caudal parts of the mesencephalic nucleus on stimulating the stretch receptors in the ocular muscles of the goat. However, Corbin (1940) using stereotaxic devices to destroy the mesencephalic nucleus was able to detect Wallarian degeneration in the nerves supplying the palate, gingiva and masticatory muscles but not in the oculomotor and trochlear nerves. Furthermore, Cooper et al (1953 a & b) succeeded to obtain action potentials in the medial longitudinal bundle on stimulation of the ocular muscles of the goat. Accordingly, the medial longitudinal bundle, the colliculotegmental fibres and the tectospinal tract could be regarded as an anatomical root along which the proprioceptive impulses from the extra-ouclar muscles reach the mesencephalic nucleus.

Some fibres from the mesencephalic root are observed by the present authors to join the brachium conjunctivum. Such contribution has also been reported by Pearson (1949 b) and Whitloock (1952) who traced mesencephalic fibres farther till the cerebellum. The payhway between the mesencephalic nucleus and the cerebellum was confirmed by experimental studies where lesions of various parts of the cerebellum or interruption of its inferior peduncle were made (Brodal and Saugstad, 1965 and Bortolami et al, 1972). This trigemino-cerebellar connection seems to play a role in conveying proprioceptive impulses from the masticatory muscles and possibly the extraocular muscles to the cerebellum.

SUMMARY

The mesencephalic root and its connections were studied in 21 adult cats. The mesencephalic root was noticed to show a gradual increase in the number of

its fibres as it proceeded caudally. Slender collaterals emerged from the root and passed both cranially and caudally in the brain stem. Some of the mesencephalic root cells contributed their axonal processes to the brachium conjunctivum and through this connection proprioceptive impulses could reach the cerebellum from the muscles of mastication and possibly the extra-ocular muscles. Furthermore, processes of some mesencephalic cells were noticed to join the colliculotegmental fibres through which it may get in connection with the oculomotor nerve and the medial longitudinal bundle.

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LEGENDS

Fig. (1) : A microphotograph of a coronal section of the brain stem opposite the anterior medullary velum showing a a group of mesencephalic cells, one of which shows axonal bifurcation.

(Sand's silver impregnation method ... X 300).

Fig. (2) : A microphotograph from a parasagittal section of the midbrain showing two collaterals, one of is directed caudally while the other is directed cranially.

(Sand's silver impregnation method ... X 250).

Fig. (3) : A microphotograph from a coronal section of the pontomesencephalic region at the anterior medullary velum (V) showing trochlear nerve fibres (T) closely applied to the lateral aspect of the mesencephalic root (M). A group of mesencephalic fibres is seen entering the velum.

(Sand's silver impregnation method ... X 112).

Fig. (4) : A microphotograph from a parasagittal section of the pontomesencephalic junction showing the crossing of the trochleir nerve root (T) to the mesencephalic root (M) in an oblique manner to reach the trochlear decussation (D).

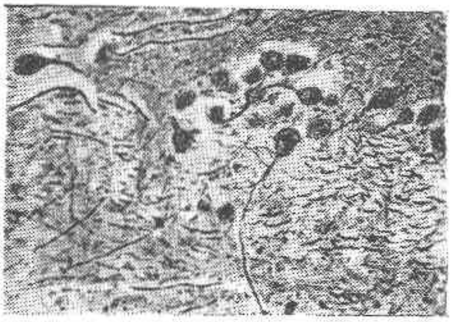
(Sand's silver impregnation method ... X 112).

Fig. (5) A microphotograph from a coronal section of the midbrain showing the intermingling of the fibres of the fibres of the mesencephalic root (M) and the brachium conjuntivum (B). Some of the mesencephalic rells are observed amidst the fibres of the brachium.

(Sand's silver impregnation method ... X 225).

Fig. (6) : A microphotograph of a showing mesencephalic cells sending parasagittal section of the midbrain their axons towards the colliculotegmental fibres (C).

(Sand's silver impregnation method . X 225).



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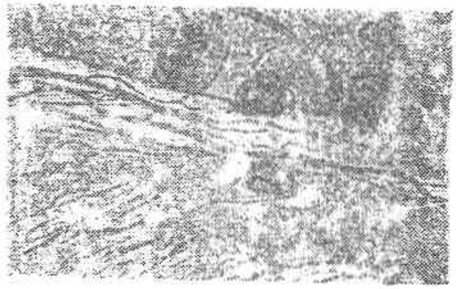

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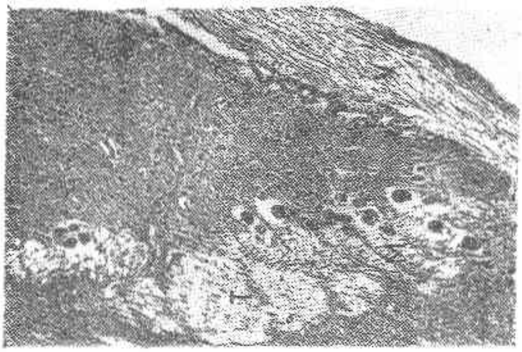

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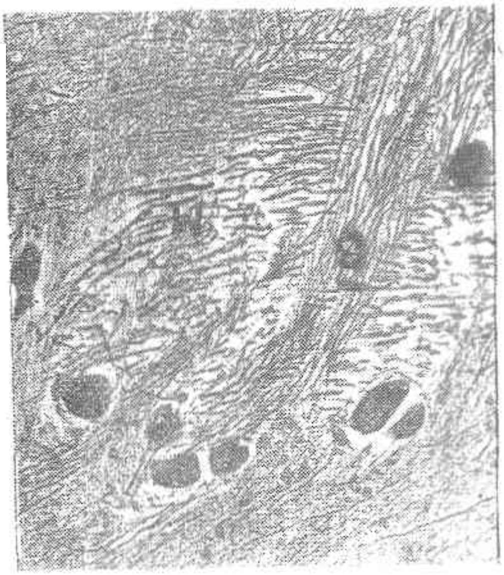

Fig. (5)

Fig. (6)