

The Duplication of the Optic Canals in Human Skulls

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ABSTRACT

Introduction: Optic canal connects the middle cranial fossa to the apex of the orbit. It is traversed by the optic nerve, ophthalmic artery, and branches from the periarterial sympathetic plexuses. Duplication of the optic canal is rare, seen in both sexes, at various ages and in a number of races

Material and Methods: The presence of duplication of optic canals was studied in 400 adult human skulls, collected from the department of Anatomy & Forensic medicine. It includes 80

skulls aged below 40 years of age and 320 skulls aged above 40 years.

Results: Duplication of optic canal was found in 11 skulls. Among which 3 skulls had Bilateral and the rest had unilateral duplication of optic canal.

Conclusion: Knowledge regarding duplication of optic canal is useful in performing surgical exploration of optic canal during tumor removal, decompression, or while approaching cavernous sinus or sella.

Key Words: Optic canal, Human, Anatomy, Cranium, Orbit

INTRODUCTION

The optic canal connects the middle cranial fossa to the apex of the orbit and it is formed by two roots of the lesser wing of the sphenoid. It is traversed by the optic nerve and its meningeal coverings, the ophthalmic artery and by the branches from the periarterial sympathetic plexuses. The artery and nerve are separated by a layer of dense connective tissue which may occasionally be ossified to result in the duplication of the optic canal. Duplications of optic canals have been reported earlier by Warwick [1], Choudhary et al [2], [3] and Mandavi Singh [4]. We took up this study to know the incidence of the duplication of the optic canal in the skulls in our state, as there were no previous studies regarding the same.

MATERIAL AND METHODS

The present study was carried at the Department of Anatomy and Forensic Medicine at VIMS, Bellary; SNMC, Bagalkot. The optic canals of 400 dry human skulls were thoroughly examined for variations. The skulls were divided into two age groups i.e. i) Below 40 years, and ii) Above 40 years, by taking into consideration, the standard points for age estimation, with the help of the staff of the Forensic Medicine department.

RESULTS

Overall, 11 (2.75%) of the 400 human skulls which were studied, showed the duplication of the optic canal. In the skulls of group I (below 40 years), there were no duplications. In the skulls of group II (above 40 years), 11 (3.44%) exhibited the duplication of the optic canal. The duplication was bilateral in 3 (0.94%) skulls [Table/Fig-1]. The duplication was unilateral in 8 (2.5%) skulls [Table/Fig-2]. In our study, there was an equal incidence of the duplication on the right and left sides, in 4 (1.25%) skulls [Table/Fig-3]. The main optic canal was in the usual position and the accessory canal was found to be inferolateral to it in the lesser wing of the sphenoid. The length of the canal was between 8-10 mm and the size of the main canal was transverse 5-10 mm, vertical 4-8 mm. Both the canals were placed

parallel to each other. The main canal was directed posteromedially and upwards and it was continuous with the anterolateral end of the chiasmatic sulcus. The length and the thickness of the septa which separated the main and the accessory canals were variable in size, but they did not exceed 1 mm in thickness in our study. Though there are reports of duplication in juvenile skulls, in our study, we found the duplication only in skulls which were aged above forty years, probably because of the increasing age, as there is more chance for the ossification of the fibrous tissue between the dura which covers the optic nerve and the ophthalmic artery.

DISCUSSION

The duplication of the optic canal is rare and it is seen in both sexes, at various ages and in a number of races. Bilateral duplications are very rare. The larger canal carries the optic nerve with the meninges, while the smaller one transmits the ophthalmic artery. (Ophthalmic canal)

There are three stages which lead to the development of the optic canal:

1. There is the formation of the cartilaginous foramen during the third foetal month.
2. Then, there is the ossification of the cartilaginous foramen.
3. Lastly, there is the transformation of the bony foramen into the bony canal.

This formation is a part of the formation of the lesser sphenoid wing. The formation of the canal occurs laterally initially, then medially,

Age of Skull	Number of skulls studied (400)	Number of skulls with duplicated optic canal			
		Total	Bilateral	Right side	Left side
Below 40 years	80	0	0	0	0
Above 40 years	320	11 (3.44%)	3 (0.94%)	4 (1.25%)	4 (1.25%)

[Table/Fig-1]: Duplication of optic canal



[Table/Fig-2]: Duplication of optic canal

and then in the superior margin of the foramen. This transformation is dependent upon the normal development of the optic strut (lower root of the lesser sphenoidal wing). The duplications of the optic canal are developmental in origin and they result from the anomalous growth of the optic strut. The latter anomaly is not due to dural ossification. The radiological findings of the optic canal asymmetry, the absent floor of the cranial opening of the optic canal, the large orbital opening in childhood and the varying course of the proximal portion of the ophthalmic artery can be explained by the developmental pattern of the optic strut [5].

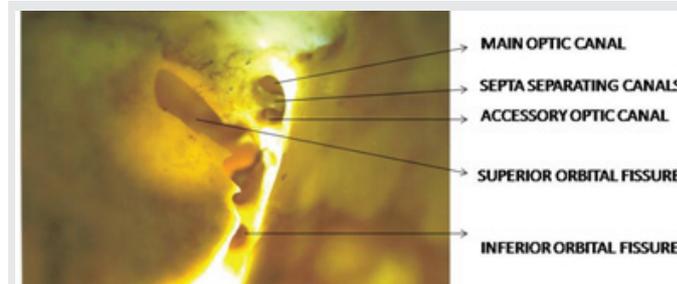
Authenticated records of duplicated optic canals were made in the late nineteenth and in the early twentieth century. There are reports of 3 cases in the newborn by White [6]. The bilateral duplication of the optic canal is very rare, which has been recorded only by very few authors- R. Choudhry [2], Lee-Double [7], Warwick [1], Orhan MA and Kayanak S [8], Mandavi Singh [4].

In a study on 435 Japanese skulls by Mandavi Singh [4], there were 13 skulls with duplicated optic canals, of which 7 skulls showed bilateral duplication. They found the duplication to be more on the left side of the male skulls, of age more than 30 years. In another study on 369 skulls by Orhan MA and Kayanak S [8], only two skulls exhibited the duplication, one unilaterally and one bilaterally.

In the study of A Berlis et al [9], there was a 2.5% incidence of the duplication of the optic canal. They studied the canal by direct measurement and by CT scan.

Why and how the duplication occurs is still not very clear, but the following theories were put forth

1. Le Double speculated that the ossification of dura which covers the optic nerve, divides the optic canal [7].
2. Augier suggested that the duplication represents the persistence of a foramen, "le trou metoptique", due to the presence of an aberrant ophthalmic vein [1].
3. Keyes JEL postulated that the bony projection in the infero lateral wall of the optic canal, when it is large, divides the optic canal [10].
4. Wolff E, is of the opinion that the fibrous tissue which separates the optic nerve and the ophthalmic artery ossifies and divides the canal [11].
5. The duplications of optic canal are developmental in origin and they result from the anomalous growth of the optic strut. The latter anomaly is not due to dural ossification [5].



[Table/Fig-3]: Bilateral duplication of optic canal

The knowledge regarding the duplication of the optic canal is useful in performing the surgical exploration of the optic canal during tumour removal and decompression, or while approaching the cavernous sinus or the sella. The knowledge of the course of the ophthalmic artery will make all the optic canal explorations safer. The use of preoperative angiography for this purpose is highly recommended [12].

CONCLUSION

Errors in identifying the anomalies of the optic canal can occur, by mistaking it for clinoid process pneumatization, posterior ethmoid air cell, carotico clinoid foramen and a defect in the greater wing of the sphenoid or in an ectopic sphenoid cellule. The variations in the optic canal can pose a dangerous situation during endoscopic optic nerve decompression and during spheno ethmoid injuries and they can also evoke confusion during the interpretation and the evaluation of the CT scans or the X-rays of the spheno ethmoid region.

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