DUPLICATION OF OPTIC CANAL IN HUMAN SKULLS

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ABSTRACT

Duplication of optic canal is a rare anomaly. 194 Human skulls were collected from the Department of Anatomy, Subharti Medical College Meerut, LLRM Medical College Meerut and Seema Dental College Rishikesh. These skulls were of the age between 18-70 years and included both male and female skulls. Out of these, 5 skulls showed duplication of optic canal. 3 skulls showed bilateral duplication and 2 skulls showed unilateral duplication . It is important to know this anatomical variation during interventional procedures of optic canal and surrounding regions especially during endoscopic tumor removal and optic nerve decompression.

Keywords: Duplication, optic canal

INTRODUCTION

Optic canal connects the middle cranial fossa to the apex of orbit and is formed by the two roots of the lesser wing of sphenoid. Optic nerve covered with cerebral meninges, ophthalmic artery and branches from sympathetic plexus around the artery traverse the optic canal. In the optic canals, optic nerve lies medial to the ophthalmic artery. Optic canal may get duplicated. Various causes of duplication of optic canal have been suggested by eminent authors [Calori 1891[1], Le Double1903[2], Augier 1931[3], Keyes 1935[4] & Leon 1996[5].] In these cases it was seen that the main canal carried the optic nerve with the meninges while the smaller canal (accessory canal) transmitted the ophthalmic artery.

MATERIAL AND METHODS:

This study was done in the department of Anatomy, Subharti Medical College, Meerut. 194 adult human skulls were collected from the department of Anatomy of Subharti Medical College, Meerut and LLRM, Medical College, Meerut and Seema Dental College, Rishikesh. These skulls were between 18 to 70 years of age and included both male and female skulls. Their optic canals were thoroughly examined for the presence of duplication and their patency were checked by passing a probe. Vertical and transverse diameters of both main and accessory canals were measured on their cerebral ends by an instrument, Castrovijo. Lengths of the main canals were measured by marked needle along the medial wall. It was not feasible to measure the lengths of the accessory canals.

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OBSERVATIONS:

Out of 194 skulls which were thoroughly examined, 5 skulls (2.57%) showed duplication of optic canal. Out of these, 3 skulls showed bilateral (1.5%) duplication and 2 skulls showed left sided unilateral (1.03%) duplication of optic canal. In each of these 5 skulls showing duplication, the duplicated canals comprised of a larger canal (main canal) which was in usual position and was directed posteromedially upward and was continuous with the anterolateral end of sulcus chiasmaticus. The smaller canal (accessory canal/ophthalmic canal) was inferolateral to the main canal in the lesser wing of sphenoid. It was directed posteriorly and on its cranial end was continuous with the sulcus for internal carotid artery at the anterior extremity of the cavernous sinus as also reported by Choudhry et al (1988[6] & 1999[7]) and Singh (2005)[8]. Main canals and accessory canals were separated by bony septa. The skulls which showed bilateral duplication were named as I, II, III and unilateral as IV and V.

In skull I length of main optic canal was 10mm on the left side and 9mm on the right side. Vertical and transverse diameters of main canals were 4 to 4.1mm. Vertical and transverse diameters of accessory canals were 3 to 3.1mm. The bony septum separating the two canals was less than 1mm in thickness and its length was approximately 4mm along the axis of the canals. Skull I was of male aged 50-60 years. In this skull other foramina such as infraorbital foramina,

mastoid foramina were very large as compared to normal skulls. Fossa for the Lacrimal sac which was present in the medial wall of orbit was converted into foramen on both sides. This skull showed tendency of excessive bone formation (Photograph-1).

In skull II length of main optic canal was 11mm on the left side and 12mm on right side. Vertical and transverse diameters of main canals were 5 to 5.2 mm. Vertical and transverse diameters of accessory foramina (canal) were 2.9 to 3mm. The thickness of the septum separating the two canals was 1mm and its length was less than 1mm. Skull II was of female aged 18-20 years. Main and accessory canals along with bony septum (left side) are shown in Photograph-2.

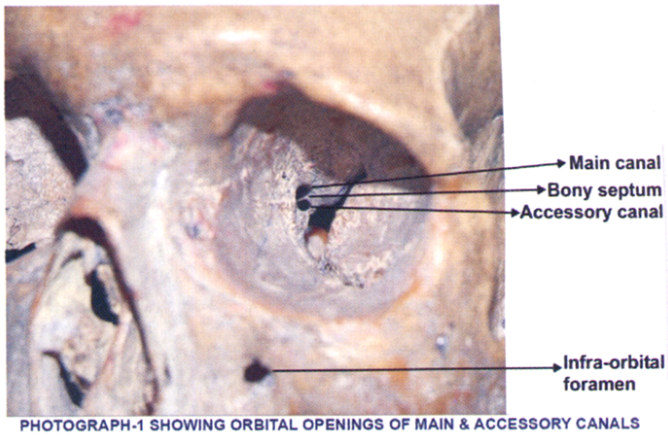
In skull III length of main optic canal was 8mm on both sides and their vertical and transverse diameters were 3 to 4.1mm. Vertical and transverse diameters of accessory foramina (canal) were 2 to 2.1mm.

TABLE I : VARIOUS MEASUREMENTS OF MAIN & ACCESSORY CANALS

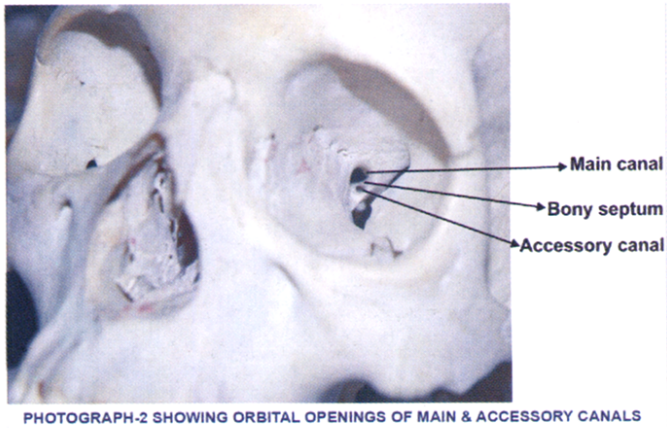
Skull		Length (mm.)		Vertical diameter (mm.)		Transverse diameter (mm.)	
		Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
Skull I	Main Canal	10	9	4	4.1	4	4
Male. 50-60 yrs.	Access. Canal	-	-	3	3	3	3.1
Skull II	Main Canal	11	12	5.1	5	5.2	5
Female. 18-20 yrs.	Access. Canal	-	-	3	2.9	3	3
Skull III	Main Canal	8	8	3	3	4.1	4
Male. 40-50 yrs.	Access. Canal	-	-	2.1	2	2	2
Skull IV	Main Canal	9	-	3.9	-	4	-
Male. 40-50 yrs.	Access. Canal	-	-	3.1	-	3	-
Skull V	Main Canal	10	-	4	-	4	-
Female. 60-70 yrs.	Access. Canal	-	-	4	-	3.8	-

TABLE II: COMPARISON OF LENGTHS OF OPTIC CANALS BY VARIOUS AUTHORS

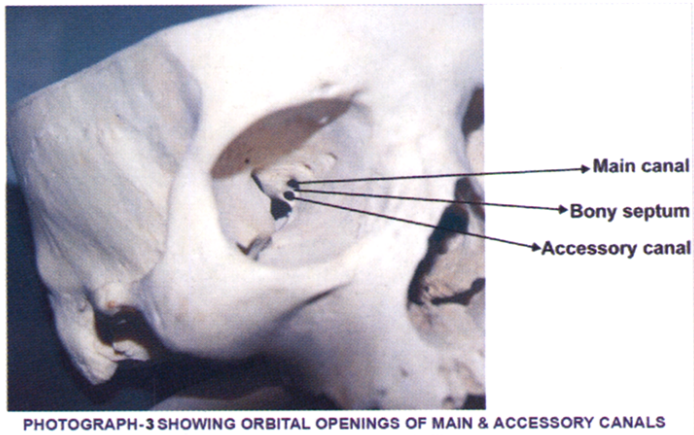
Author (s)	Length of optic canal
Wolff (1976)[18]	10-12 mm. (in normal skulls)
Choudhry (1988)[6]	9-11 mm. (along medial wall)
Patil (2011)[16]	8-10 mm.
Present study	8-12 mm. (along medial wall)



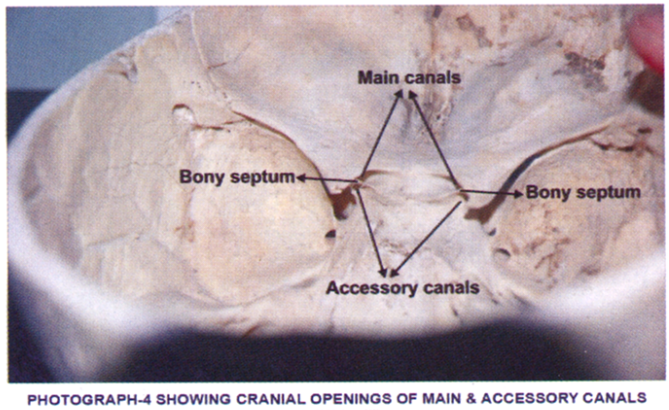
PHOTOGRAPH-1 SHOWING ORBITAL OPENINGS OF MAIN & ACCESSORY CANALS (LEFT ORBIT - SKULL I)



PHOTOGRAPH-2 SHOWING ORBITAL OPENINGS OF MAIN & ACCESSORY CANALS (LEFT ORBIT - SKULL II)



PHOTOGRAPH-3 SHOWING ORBITAL OPENINGS OF MAIN & ACCESSORY CANALS (RIGHT ORBIT - SKULL III)



PHOTOGRAPH-4 SHOWING CRANIAL OPENINGS OF MAIN & ACCESSORY CANALS (SKULL - III)

Thickness of the septum separating the two canals was less than 1mm and its length was less than 1mm. Skull III was of 40-50 years male. Main and accessory canals along with bony septum (right side) are shown in Photograph-3. Cranial openings of main and accessory optic canals of both sides are shown in Photograph-4.

In skull IV unilateral duplication of optic canal was seen on the left side. The length of main optic canal was 9 mm and its vertical and transverse diameters were 3.9 mm & 4 mm respectively. Vertical and transverse diameters of the accessory canal were 3 to 3.1mm. Thickness of the septum separating the two canals was less than 1mm and its length was less than 1mm. Skull IV was also of 40-50 years male.

In skull V unilateral duplication of optic canal was seen on the left side. Length of main optic canal was 10mm and its vertical and transverse diameters were both 4 mm. Vertical and transverse diameter of accessory canal was 4mm and 3.8mm respectively. Thickness of the septum separating the two canals was about 1.8 mm and its length was 3mm. Skull V was of 60-70 years female.

DISCUSSION :

Duplication of optic canal has been seen in both sexes at various ages and in a number of races by various authors.

Zoja (1885)[9] reported 5 cases out of which 4 had unilateral (male) and one had bilateral (female) duplication of optic canal. Le Double (1903)[2] reported single bilateral case (Male). Keyes (1935)[4] examined 2187 skulls, out of which 36 had duplication (1.6%). White(1942)[10] reported 3 cases of duplication of optic canal in the new born while Whitnall (1932)[11] made a photographic report of this condition. Warwick (1951)[12] reported bilateral duplication of optic canal in only one child at postmortem examination. Choudhry R et al (1988[6] &1999[7]) in their study found duplication in 3 skulls, out of which 2 had bilateral while 1 had unilateral duplication of optic canal. Berlis et al (1992)[13] stated that there was 2.5% incidence of duplication of optic canal. Orhan and Kaynak, (1996)[14] after studying 369 skulls reported that only two skulls had duplication, one unilateral and one bilateral (0.3%). Singh (2005)[8] did her study in 435 Japanese human skulls and reported that only 13 skulls (4%) had duplication of optic canal, out of which only 7 showed bilateral duplication(1.6%) and 6 (1.38%) showed unilateral duplication of optic canal . Math et al(2010)[15] reported 2 cases of bilateral duplication (0.6%) of optic canals out of 316 macerated adult skulls of both sexes. Patil et al (2011)[16] examined 400 skulls and found duplication of optic canal in 11 (2.75%) skulls out of which 3 skulls had bilateral duplication (0.94%) while unilateral duplication was found in 8 (2.5%)skulls. Length of optic canal measured by different authors are given in Table II

In our study of 194 human skulls ,5 (2.57%) showed duplication of optic canal . 3 had bilateral (1.5%) and 2 had unilateral (1.03%) duplication of optic canal.

Various authors have suggested different causes of duplication of optic canal. Calori (1891)[1] and Le Double (1903)[2] both ascribed this anomaly due to ossification of process of duramater between the optic nerve and ophthalmic artery. Leon (1996)[5] & Scheuer (2000)[17]stated that this anomaly is not due to dural ossification but the duplication of optic canal is developmental in origin and it results from the anomalous growth of the optic strut. According to Augier (1931)[3] duplicity of optic canal represent the persistence of a foramen "le trou metoptique" which he had frequently encountered in foetal skulls. He regarded this foramen as being due to the presence of an aberrant ophthalmic vein. Keyes (1935)[4] postulated that the bony projection ,when large, could result in the division of the optic canal into two parts, upper and larger for optic nerve and lower for the ophthalmic artery.

Developmental basis of duplication of optic canal

The formation of optic canal is part of formation of lesser wing of sphenoid. The ossification center for the lesser wings are formed in the ala oribitalis cartilage at about 12 fetal weeks. Between 12-16 weeks two centers form in the cartilage on the superior and the lateral side of the cartilagenous optic foramen which rapidly fuse together. By 16 weeks optic foramen is almost surrounded by bone. A small linear process, anteroinferior segment of the optic strut extends from the lesser wing and fuses with the postsphenoid center of the body of sphenoid bone to form the inferolateral border of the optic foramen. At this stage the foramen resemble the key hole with the ophthalmic artery occupying the inferior narrower part and the optic nerve above it in the wider part. The optic canal as opposed to the foramen starts to form during the 5th month of the fetal life with the formation of second or posterosuperior strut which joins the

lesser wing to the presphenoid center of the body of sphenoid bone.Normally at this time ophthalmic artery takes up a more superior position above the second strut and becomes incorporated into the dural sheath of the optic nerve. So for a relatively short time optic strut is composed of two segments enclosing a transitory foramen between them which on its closure forms the cranial opening of the optic canal. Malformation that may be associated with this stage of development is the figure of 8 anomaly.

This anomaly occurs when the second strut develops above, instead of below the ophthalmic artery so it and the optic nerve occupy separate foramina at the cranial entrance to the canal. This leads to the duplicated optic canal (Scheuer et al 2000)[17].

CONCLUSION:

In this study we got five skulls with duplicated optic canal. It is important to keep this anatomical variation in mind during interventional procedures of optic canal and surrounding regions ,especially during endoscopic tumor removal and optic nerve decompression. It can also be misinterpreted as carotico-clinoid foramen or posterior ethomoidal air cells during radiological investigation of spheno-ethmoidal region.

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