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ORIGINAL ARTICLE

INFRAORBITAL SULCUS: A STUDY IN 100 SKULLS

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ABSTRACT: INTRODUCTION: A study was done on 100 intact, unsexed human skulls in the Department of Anatomy, KIMS, Bangalore, to observe and record the presence of a groove in the lateral wall of the orbit, synonymous with infra orbital sulcus. This entity has been described by the fortieth edition of Gray's text book of Anatomy to extend from the lateral end of superior orbital fissure to the orbital floor. It sometimes contains an anastomosis between middle meningeal artery and infra orbital artery. The upper end of the groove may coincide with the cranioorbital foramen (of Hyrtl, synonymous with foramen meningoorbitale).Material& Methods: 100 intact unsexed adult human skulls from the department of Anatomy KIMS Bangalore were studied. They were presumed to be of South Indian origin. **RESULTS:** In the present study 52 grooves were present in 200 orbits, of which 25 were on the right and 27 on the left. The origin of the groove from the cranio orbital foramen occurred once on the left. **DISCUSSION:** the results of the present study have been compared with previous workers. The authors hope that the study will be of use to ophthalmologists, neurosurgeons and anthropologists.

KEYWORDS: Infra Orbital Sulcus, Groove, Anastomosis, Middle Meningeal Artery, Cranioorbital Foramen.

Fig. 1: RIGHT ORBIT

UPPER ARROW – CRANIOORBITAL FORAMEN.
LOWER ARROW – GROOVE IN LATERAL WALL OF ORBIT.

INTRODUCTION: The infraorbital sulcus is described to extend from the superolateral end of the superior orbital fissure towards the orbital floor. It is sometimes associated with an anastamosis between middle meningeal and infraorbital arteries.[1] Low in 1946 was the first to describe a groove in the lateral wall of the orbit. His paper on anomalous middle meningeal artery, in the bilateral absence of foramen spinosum was a case of a single skull.

The skull showed bilateral intra orbital groove extending from foramen meningoorbitale to the inferior orbital fissure. He deduced that in the single skull the middle meningeal artery arose from the infra orbital artery[2]. Subsequently Royle (1973), Siddiqui (1978), Santoneto et al (1984) Mysorekar and Nandedkar (1987) all studied the groove in the lateral wall of orbit and postulated the cause to be an anastomosis between middle meningeal artery and infra orbital artery. Micheal Diamond (1990) had a new inter pretation based on the dissection of the lateral wall of the orbit and was of the opinion that the groove was an artefact produced by the abrupt thinning of the bone.[3]

In his 1991 paper Micheal Diamond gave embryological reasons for arteries passing through the superior orbital fissure and foramen meningoorbitale.[4] Other workers like Erturk (2005) and Alexandra O` Brien have mentioned the presence of the groove in the lateral wall of the orbit. The present study was done to find the incidence of the groove and its relationship to the cranio orbital foramen in South Indian population.

Since the infra orbital sulcus may contain an anastomosis between middle meningeal artery and infra orbital artery it would be of surgical interest to ophthalmologists, and neuro surgeons. The comparison of the incidence of the groove with workers in other countries of the world will be of value to the anthropologists.

MATERIALS AND METHODS: 100 intact unsexed adult human skulls from bone sets of MBBS, BDS, BPT students, the skeletons in Anatomy department of KIMS, Bangalore, of presumed South Indian origin. In the intact orbits of right and left sides of the skulls, the presence or absence of the groove, its extent: superior and inferior, the presence bilaterally, relation of the groove to cranio orbital foramen were documented.

RESULTS: The groove was present in 52 of 200 orbits in one hundred skulls i.e. 26%. On right side it was found in 25 of 100 orbits and 27 of 100 orbits on the left. In 16 skulls the groove was bilateral. The cranio orbital foramen was present in 37 skulls on the right and 32 skulls on the left. In one skull on the left side the infra orbital sulcus arose from cranioorbital foramen.

DISCUSSION: EMBRYOLOGY: The source of blood supply to the territory of the trigeminal nerve varies in different stages of development. When the first and second aortic arch arteries begin to regress, the supply to corresponding arches is derived from a transient ventral pharyngeal artery that grows from the aortic sac. It terminates by dividing into mandibular and maxillary branches. Later the stapedial artery develops from the dorsal aspect of the second arch artery and passes through the condensed mesenchymal site of the future ring of stapes to anastamose with the ventral pharyngeal artery thereby annexing its terminal distribution.

The fully developed stapedial artery possesses three branches mandibular, maxillary and supraorbital which follow the divisions of the fifth nerve. The mandibular and maxillary divisions arise from a common stem. When the external carotid artery emerges from the base of the third arch it incorporates the stem of the ventral pharyngeal artery. Its maxillary branch communicates with the common trunk of origin of maxillary and mandibular branches of stapedial artery and annexes these vessels.

The proximal part of the common trunk persists as the root of the middle meningeal artery, more distally the meningeal artery is derived from proximal part of supraorbital artery. The maxillary branch becomes the infraorbital artery and the mandibular branch, the inferior alveolar artery. When the definitive ophthalmic artery differentiates as a branch from the terminal part of the internal carotid artery it communicates with supraorbital branch of stapedial artery, distally this becomes the lacrimal artery. The latter retains an anastomotic connection with the middle meningeal artery.[5]

The supraorbital part of the stapedial artery forms in addition extraocular intraorbital arteries, the intracranial part of the middle meningeal artery. After the intraorbital branches of the stapedial artery are assimilated by the ophthalmic artery its proximal intra and retro orbital branches involute and become reabsorbed by the intracranial segment of the middle meningeal artery.[6]

The middle meningeal artery may partially (only the anterior division) or completely arise from ophthalmic artery. Under such circumstances it passes through the lateral end of superior orbital fissure or through a foramen in the greater wing of sphenoid (foramen meningoorbitale). This is called ophthalmic middle meningeal artery.[6]

COMPARATIVE ANATOMY: In humans as well as all placental mammals arteries of the orbit (except those supplying the eyeball) are derived from embryonic stapedial artery. At 14-18 mm stage of development; this artery, branch of internal carotid artery is a major supplier to all non-neural tissues of head. The stem of the stapedial artery enters what will eventually be the cranial cavity and divide into ramus superior and ramus inferior.

Ramus superior runs forward to the orbital region and gives off branches that accompany lacrimal, frontal and nasociliary nerves. At 20mm stage, stem of ophthalmic artery annexes ramus superior near the optic nerve. Subsequently connection between intracranial and intraorbital parts of ramus superior involutes. Intraorbital part of ramus superior and its lacrimal branch are transformed into definitive lacrimal artery of human adult.

Ramus superior persists into adulthood as the intracranial part of middle meningeal artery. Wible (1987) recognized anterior and posterior divisions of the ramus superior. It is the anterior division that communicates with the orbit. The anterior division is largely not completely homologous with anterior branch of middle meningeal artery, (Diamond 1988).[4]

In primitive placental mammals and many primates ramus superior of stapedial artery enters orbit through the cranioorbital foramen renamed ramus supraorbitalis.[4]

GROSS ANATOMY: The vessels passing through the superior orbital fissure and the cranioorbital foramen contribute to arterial supply of anterior part of dura of middle cranial fossa and form anastomoses between ophthalmic artery and middle meningeal artery or dural branches of internal carotid artery. Stienberg (1987); Price et al (1988) showed that the orbital branch passing through cranioorbital foramen might be clinically important as an accessory blood supply to the orbital contents. During reconstruction of anterior base of the skull and of the orbit during orbital base surgery orbital branch passing through cranioorbital foramen may be damaged and large part of blood supply to the orbit may be lost.

Orbital branches of middle meningeal artery passing through cranioorbital foramen is thought to be main vascular supply to meningiomas in the anterior cranial fossa as indicated by Kuru (1967).This is of importance in excision of meningiomas and the surgeon needs to have preoperative knowledge of the pattern. Gabriele and Bell (1967) stated that if meningiomas are supplied by meningeal branches that anastamose with the lacrimal artery branches there may be striking and clinically important enlargement of the ophthalmic artery and its branches.[7]

REVIEW OF LITERATURE: Gavin Royle (1973) studied 32 skulls of presumed Asian origin. He found a bilateral groove in a single skull like that described by Low extending from foramen meningoorbitale to the inferior orbital fissure. There was one case of similar unilateral groove. In 19 samples the intraorbital groove described arose from superior orbital fissure.

Wood Jones (1911) stated that middle meningeal markings on the inside of the skull are made by veins but also indicate position of both arteries and veins. The intraorbital grooves in this paper were found to be continuous with orbital branch of middle meningeal vessels found in the middle cranial fossa. Thus it is probable the intraorbital grooves indicate the position of blood vessels.

Hayreh & Dass undertook a series of studies on ophthalmic artery and its branches by injection techniques. An anastomosis between middle meningeal artery and recurrent meningeal branch of lacrimal artery was found to be usual. The anastomosis passed either through superior orbital fissure or through foramen meningioorbitale.

Anastomoses were also noted between lacrimal and infraorbital artery and between infraorbital artery and muscular branches of ophthalmic artery. Thus anastomoses may be postulated between infraorbital and middle meningeal artery via lacrimal artery. It is probable that infraorbital groove described in this paper could be an indication of the position of blood vessels taking part in such an anastomosis.[2]

Royle & Motson (1973): Origin and distribution of middle meningeal vessels is of surgical importance, for example concerning extradural haemorrhage. Knowledge of their anomalies is of importance. Padget (1948) found that middle meningeal artery is formed from common stem of mandibular and maxillary branches of stapedial artery (external carotid artery fusing with this stem); and proximal part of supraorbital branch of stapedial artery.

Lacrimal artery is formed from distal part of supraorbital branch of stapedial artery and from branch of ophthalmic artery which anastomoses with it. Thus supraorbital part of stapedial artery is common to both middle meningeal and lacrimal arteries; explains anastamosis between them. In adults recurrent meningeal branch of lacrimal artery either passed through superior orbital fissure or foramen meningo orbitale.[8]

Siddiqui (1978): From Lucknow; India studied the groove in 125 skulls. The groove was present in 47 cases (37.6%). In 4 of them the upper end of the groove arose from the foramen meningoorbitale, two on right side and two on the left (3.2%), in the remaining 43 the groove passed from lateral end of superior orbital fissure to posterior end of inferior orbital fissure. On right side it was observed in 27 (21.6%); in 2 skulls (1.6%) on the right side.in 18 skulls (14.4%) it was present on both sides. There was no case in which two grooves were present, one from foramen meningoorbitale and one from the superior orbital fissure.

The groove probably lodges blood vessels taking part in an anastamosis between the middle meningeal and infraorbital vessels, Hayreh et al[9]. Santo neto, Penteado, Carvalho (1984): Study conducted on 50 dry skulls of Brazilian whites, negroes and mulattoes of both sexes. The authors documented the following results: right orbits-groove present in 24 cases. Foramen meningoorbitale in 3 cases. Left orbits, 21 grooves seen. Presence of groove bilaterally in 15 skulls. In no skull did the groove arise from foramen meningo orbitale.[10]

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Mysorekar and Nandedkar (1987): Studied 100 human skulls, in Pune. India. The groove was found, 16 on the right and 21 on the left. They found 38 foramen meningoorbitale on right and left side. All the grooves arose from the lateral end of superior orbital fissure except one on the left that arose from foramen meningoorbitale.6 skulls had bilateral grooves, 10 showed only on right And 15 only on the left. None of the orbits showed double groove and all grooves ended at posterior end of inferior orbital fissure.[11]

Diamond (1990): Dissection of 47 orbits was made in which 4 grooves were observed, no artery was observed in any of the grooves.in one weak groove a small vein was seen. In two cases the groove coincided with abrupt thinning of greater wing that marked a transition from cancellous to compact bone. He concluded the transition from cancellous to compact bone is sometimes marked by a step and an associated shadow that resembled a vascular trace.[3]

Erturk (2005): Studied 170 skulls and put forth the following findings, the groove was observed in 122 skulls (71.6%), unilateral in 40 (23.5%), bilateral in 82 (48.2%) the groove arose from cranioorbital foramen in 20 skulls (11.8%).[7]

Alexandra O'Brien and Stuart W. McDonald (2007) in their study on 30 male skulls in Scottish population found the following 1 skull showed the groove and it was bilateral. Upper end of the groove was at the lateral end of the superior orbital fissure and lower end at the posterior boundary of inferior orbital fissure near its medial end. This skull displayed 2 meningoorbital foramina on the right and none on the left. In the right orbit both foramen connected to middle cranial fossa.[12]

Present Study: In 100 intact unsexed adult human skulls of presumed South Indian population in the department of Anatomy, Kempegowda Institute of Medical Sciences, Bangalore, India. The Infraorbital sulcus, synonymous with the groove in the lateral wall of the orbit was 52 in number i.e 26%. It was found in 25 of 100 orbits on the right side & 27 of 100 orbits on the left side. In 16 skulls it was bilateral. In one skull the groove arose from cranioorbital foramen on the left side.

When we compare the result of the present study with previous studies of Indian authors, the following observations are noted. Siddiqui (1978) made a study on skulls of North Indian population, Mysorekar and Nandedkar (1987) studied skulls of Western Indian population and our study was South Indian population. No coastal influences are there, as their presence might have altered ethnicity. Hence all skulls were of Indian origin.

The percentage of grooves was lower in the present study. In all Indian studies there was preponderance of the groove on the left though in Siddiqui`s study it was markedly so. The bilateral nature of the groove was decidedly lower in the present study but not significant as Siddiqui had studied 125 skulls and both the study of Mysorekar and the present study were 100 in number. The upper extent of the groove was at the lateral end of the superior orbital fissure in most orbits.

In the study of Siddiqui, in 4 skulls the groove had its upper end co-inciding with cranioorbital foramen. In both the study of Mysorekar and present study the upper end of the groove arose from the cranioorbital foramen on the left in a single skull. (Table 1).

Comparison of results of present study with authors of other countries revealed the following: Royle (1973), and Alexandra O`Brien (2007) studied nearly the same number; though the former stated that his study used Asiatic skulls and the latter Scottish skulls. Royle, in his study found 11 grooves and Alexandra O`Brien found 2 grooves, none arose from cranioorbital foramen. Bilateral groove was found in a single skull in the studies of both these authors.

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Santo neto et al (1984) studied 50 skulls of Brazilian population.45 grooves were found. This is very high in general. The groove was bilateral in 15 skulls. The groove was more prevalent on the right than the left side. No groove arose from cranioorbital foramen.

Erturk (2005) studied skulls of Turkish population of 170 skulls, 122 grooves were found. The percentage is high, however less than Santo neto et al. The number of grooves is more on the left than right side, as it was in Indian studies. Bilateral groove was seen in 6 skulls. In 20 skulls the groove arose from cranioorbital foramen. This figure is higher than Siddiqui. (Table 2).

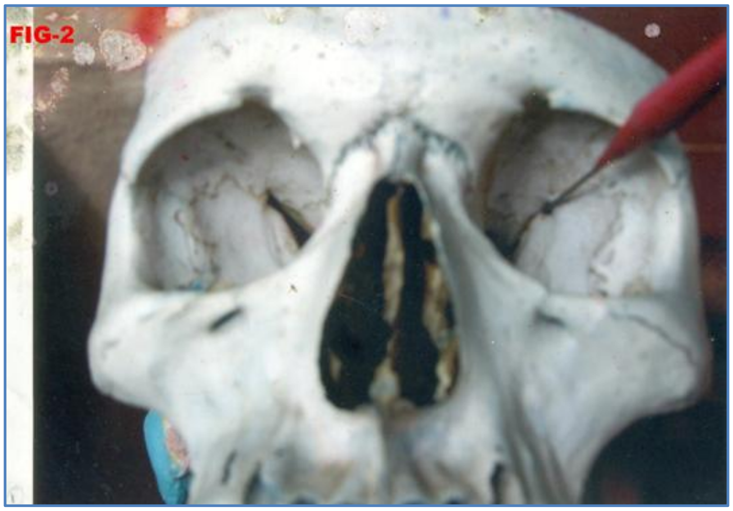

Fig. 2: BILATERAL GROOVE

Fig. 3: GROOVE ARISING FROM CRANIOORBITAL FORAMEN ON THE LEFT SIDE

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AUTHOR & YEAR	No. of skulls	No. of grooves	% of grooves	Right side no. of grooves	Left side no. of grooves	Bilateral grooves	No. of grooves Arising From cranio orbital foramen
Siddiqui (1978)	125	47`	37.6%	2	27	18	4
Mysorekar (1987)	100	30	30%	16	21	6	1
Present Study (2014)	100	52	26 %	25	27	16	1

Table 1: COMPARISON OF PRESENT STUDY WITH OTHER INDIAN AUTHORS

AUTHOR & YEAR	Nationality Of skulls studied	No. of skulls	No. of grooves	% of grooves	Right side no of grooves	Left side no. of grooves	Bilateral grooves	No. of grooves Arising From cranio orbital foramen
Royle (1973)	Asiatic	32	11	34.4%	-	-	1	Nil
Santoneto et al(1984)	Brazilian	50	45	90%	24	21	15	Nil
Erturk (2005)	Turkish	170	122	71.8.%	13	27	6	20
Alexandra O` Brien (2007)	Scottish	30	2	7%	1	1	1	0
Present Study (2014)	South Indian	100	52	26%	25	27	1 6	1

TABLE 2: COMPARISON OF PRESENT STUDY WITH FOREIGN AUTHORS

CONCLUSION: The groove in the lateral wall of the orbit or the infraorbital sulcus is an anatomical entity. The presence of the groove is not just of surgical interest to ophthalmologists and neurosurgeons but also to anthropologists. This is due to the presence of an anastomosis between middle meningeal and infraorbital artery and the variable incidence in different populations.

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