CHAPTER II

REVIEW OF RELATED LITERATURES

Approaches to the orbit have traditionally been standardized based on the bony landmarks located around the orbital rim. The precise knowledge of anatomy is the key to avoid injury to the intraorbital contents especially neurovascular bundles passing through the orbital apertures. There are some related studies about the surgical anatomy of apertures in the orbit.

In 1961, Kirchner and coworkers [11] described the anatomy of the ethmoidal foramina and the structures that passed through each in human dried skulls (the origin was not given). They measured the distances from the maxillo-nasal-lacrimal junction as a constant landmark to anterior ethmoidal foramen, postarior ethmoidal foramen and optic canal. They reported that approximately 33% of the anterior ethmoidal foramina lie above the frontoethmoid suture line and the average distance was 1 - 4 mm. The distance between anterior ethmoidal foramen to posterior ethmoidal foramen was 11 (3 - 17) mm and between posterior ethmoidal foramen to optic canal was 5.75 (2 - 16) mm. There was often more than one posterior ethmoidal foramina. The data did not give standard deviation.

In 1979, Rontal and coworkers [12] were the early group which studied the surgical anatomy of the orbit. They used 24 human dried skulls from India, determined by dentition to be adult and gender were separated by the prominence of the occipital protuberance (but no data of number of each gender). Sample means and ranges were reported. The constant landmarks on the orbital rim were easily identified and readily accessible. The distances from these points to

different apertures of walls of the orbit were measured. After that, the safe distance for each wall was proposed.

The constant landmark of the medial wall was the anterior lacrimal crest. 25% of the specimens had more than one posterior ethmoidal foramen. The distance between the farthest posterior ethmoidal foramen to optic canal was 7 (3 - 12) mm. This distance is variable but not less than 3 mm. Therefore, dissection beyond this point must be done with great caution. They suggested that 30 mm was the safe distance for this wall.

For superior wall, the distances from the supraorbital notch or foramen to the superior orbital fissure, lacrimal foramen and superior aspect of optic canal were measured. The distance between the supraorbital foramen to the superior orbital fissure was 40 (35 - 45) mm. The dissection allowed a 5 mm tolerance to the most anterior aspect of the closest superior orbital fissure. They suggested that 30 mm was the safe distance for this wall.

For inferior wall, the distances from the infraorbital foramen to the inferior orbital fissure, lateral margin of lacrimal fossa, covered portion of infraorbital nerve, posterior wall of maxilla and inferior aspect of optic canal were measured. The posterior portion of maxilla was 26 - 44 mm from the infraorbital foramen, and they suggested 25 mm, which was 1 mm shorter than the lowest value, as the safe distance.

For lateral wall, the distances from the frontozygomatic suture to the superior and inferior orbital fissures, lacrimal foramen and lateral aspect of optic canal were measured. The distance between the superior orbital fissure and the frontozygomatic suture was 28 - 38 mm. They suggested 25 mm, which was 3 mm shorter than the lowest value, as the safe distance.

Rontal's study also reported that there was no difference between right and left or male and female orbits with greater than 95 % confidence. But the standard deviations were not available, so other studies could not statistically compare the racial differences.

Later in 1995, McQueen and colleagues [13] reported the surgical anatomy of the orbit like Rontal, *et al.*, but this study used 54 cadaveric orbits in the United States. The only one orbit from each cadaver was analyzed because another side was also being studied by medical and dental students. These orbits were composed of 27 females and 27 males, 6 black and 48 white race, and 34 left-side and 20 right-side orbits. Sample means, standard deviations and ranges were reported.

Comparing the data with that of Kirchner, *et al.*, McQueen, *et al.* showed that only 4 % of the anterior ethmoidal foramen above the frontoethmoid suture line (average distance = 2.4 mm) and other measurements were longer than those of Kirchner, *et al.*

McQueen, *et al.* found that 72 % of the infraorbital grooves were covered back to the inferior orbital fissure. The number of lacrimal foramina which was not mention in Rontal, *et al.* was found 44 %. Multiple foramina posterior to the anterior ethmoidal foramen were also found in this study which was similar to previous studies.

For comparing the data in McQueen, *et al.* with that of Rontal, *et al.*, most of these measurements were of greater distances. They suggested that the bony orbit of Indian skulls was slightly smaller than that of those in United States. But Rontal, *et al.* did not report the standard deviations, therefore no statistical comparison could be made between the studies.

For gender, racial and side differences, there were no statistically significant except the posterior ethmoidal foramen in females was closer to the optic canal than that in males.

McQueen, *et al.* also suggested that the safe distances should be 5 mm subtracted from the shortest distances from the orbital rim to the optic canal. These distances were 29, 39, 38, 36 mm for medial, inferior, superior and lateral walls, respectively.

In 1998, Danko and coworkers [14] reported the investigation of the safe distance for internal orbital dissection by using the method which differed from previous studies. The eight male human cadavers were dissected to the orbital rim and internal orbit. An imaginary horizontal line was then established through the attachments of the medial and lateral canthal ligaments, and then another line was made perpendicular to the first line through the infraorbital foramen. Two additional lines were created at 45 degree to the first line. A straight probe was then used to measure the distance from the retracted orbital apex soft tissue to the point where each end of the four reference lines crossed the orbital rim, creating eight reference points. They reported that these distances were a range from 31.0 - 51.1 mm. They suggested that these measurements were valuable in the surgical setting.

In 1999, Hwang and colleagues [15] studied similar to Rontal, *et al.* They examined 82 orbits from 41 adult Korean skulls (the numbers of each gender was not shown). The means and standard deviations of the distances from the periorbital bony landmarks to vital orbital structures were measured. They could not statistically compare the racial differences with Rontal's data because the standard deviations were not available in Rontal's study. They proposed the safe

distances for dissection. For gender and side, they found statistically different in some distances.

Karakas and coworkers [16] reported morphometric measurements from various reference points in 2002. This study was similar to Rontal's and Hwang's studies. They used 62 orbits from 31 male adult Caucasian skulls (aged 30 - 50 years). The results of this study were compared with previous reports. On average there was a similarity of the medial and lateral wall measurements. However, there were some differences in the results on the inferior and superior walls. They considered that the diversity could be a result of some factors such as age, gender, race and differences in the reference points.

In 2004, Akdemi and coworkers [17] described the anatomical landmarks for transethmoidal approach to the opic canal for optic nerve decompression. They measured 25 adult human skulls in Turkey by method which was similar to Kirchner, *et al.* They used these distances for further investigation on their cadaveric dissection and radiologic studies.

Other interested studies about variations in size and in symmetry of foramina of the human skull, such as in 2001, Berge and colleagues [18] studied 100 dried skulls in United State. They found that no side differences on the average size of most foramina. On the other hand, They also reported the symmetry of paired foramina, for example the anterior ethmoidal foramen was found unilateral only 1 % and not presented absent bilaterally. The lacrimal foramen was highly variable in size and symmetry. The presented bilateral openings were found only 44 %.

In 2005, Agthong and coworkers [19] examined the different anatomical variations of the supraorbital, infraorbital and mental foramina related to gender

and side in 110 adult Asian skulls. They found similar frequencies of supraorbital foramen and notch bilaterally. The frequency of this absence was 5.5 % on the right and 10.0 % on the left. The infraorbital foramen was found that single foramen was the most frequent pattern. There were gender and side differences in any measurements of the distances from the supraorbital and infraorbital foramina to reference points.

Comparison of some distances from the constant landmarks on the orbital rim to the orbital apertures in the previous studies are shown in Table 1.

Table 1 : Comparison of some distances from the constant landmarks on the orbital rim to the orbital apertures in the previous studies

Walls of orbit	From	To	Rontal et al (1979) (48 orbits)	McQueen et al (1995) (54 orbits)	Hwang et al (1999) (82 orbits)	Karakas et al (2002) (62 orbits)
			mean(mm)	mean±SD(mm)	mean±SD(mm)	mean±SD(mm)
Medial	ALC	OC	42	43.29±4.19	40.5±3.0	41.7±3.1
		AEF	24	21.96±3.13	21.0±3.3	23.9±3.3
		PEF	36	33.36±2.94	31.7±3.0	35.6±2.3
Roof	SN/F	OC	45	48.65±3.21	44.9±2.0	45.3±3.2
		SOF	40	44.34±3.97	40.0±2.5	
		LF	32	38.99±4.55		
Floor	IF	OC	48	49.73±2.71	45.5±2.5	
		IOF	24	37.43±4.13	21.6±1.8	
		PM	14	17.08±3.64		
Lateral	FZ	OC	43	47.10±2.88	47.4±3.0	44.9±2.5
		SOF	35	36.59±4.30	34.3±2.7	
		IOF	25	40.92±3.62	24.8±2.3	
		LF	25	31.41±5.78		

ALC = anterior lacrimal crest

AEF = anterior ethmoidal foramen

PEF = posterior ethmoidal foramen

OC = optic canal

SN/F = supraorbital notch or foramen

IOF = inferior orbital fissure

SOF = superior orbital fissure

LF = lacrimal foramen

FZ = frontozygomatic suture

PM = posterior margin covering of infraorbital nerve

IF = orbital rim above infraorbital foramen (in Rontal *et al.* = infraorbital foramen)