

## MORPHOMETRIC ANALYSIS AND VARIATION IN THE INFRAORBITAL FORAMEN OF THE ADULT HUMAN DRY SKULL IN NORTH INDIA AND ITS ANAESTHETIC SIGNIFICANCE

Roshan Kumar Yadav<sup>1</sup>, Sadakat Ali<sup>2</sup>, Shashi Munjal<sup>3</sup>

<sup>1</sup>Ph.D. Scholar, Department of Anatomy, S.G.R.R.I.M. and H.S., Patelnagar, Dehradun, Uttarakhand, India.

<sup>2</sup>Professor and Head, Department of Anatomy, S.G.R.R.I.M. and H.S., Patel nagar, Dehradun, Uttarakhand, India.

<sup>3</sup>Professor and Head, Department of Anatomy, G.B.C.M., Jhajhara. Dehradun, Uttarakhand, India.

Received : 19/06/2023  
Received in revised form : 25/07/2023  
Accepted : 05/08/2023

### Keywords:

IOF - infraorbital foramen; IOM - infraorbital rim; AIOF - accessory infraorbital foramen; Rt- Right; Lt- Left.

Corresponding Author:

**Dr. Sadakat Ali,**

Email: drsadakat786@gmail.com

DOI: 10.47009/jamp.2023.5.4.260

Source of Support: Nil,

Conflict of Interest: None declared

Int J Acad Med Pharm  
2023; 5 (4); 1287-1291



### Abstract

**Background:** The suborbital margin is formed laterally by the zygomatic bone and medially by the maxillary bone. The infraorbital foramen is located on the maxillary bone, approximately 1 cm below the infraorbital edge for the passage of infraorbital vessels and nerves. **Materials and Methods:** Infraorbital foramen (IOF) being bilateral, the total study was done on 250 IOFs of 125 skulls whereas 68 were male and 57 were female. All the parameters were obtained by the direct vision method and for the direction of the infraorbital, the plastic-coated single-core flexible wire was used. **Result:** In the present study the shape of IOF were found round shape in male 62.4% and female 48.24%, oval shape 38.80% in male and female 42.10%, Triangular in males 4.41% and in female 3.51%, Semilunar in male 5.88% and 2.63% in females. Position of Foramen in correlation to the supraorbital foramen or notch in males were Central to SOF 15.44% and in females 18.42%, lateral to SOF 76.47% in male and 71.05% in females, Medial to SOF 8.09% in males and 7.89% in females. Presence of an accessory infraorbital foramen (AIOF) an AIOF of 5.88% for males and 6.14% for females, two AIOF of 0% for males and 0.87% for females. The direction of suborbital foramen Inferiorly 63.23% in males and 66.66% in females, Vertical 27.20% in males and 24.56% in females, and Median 7.35% in males and 7.01% in females. Location of Foramen in correlation to the uppers maxillary teeth the IOF mostly lies in between the upper 2<sup>nd</sup> premolar & 1<sup>st</sup> molar 47.45% in males and the same on the right & left side and 47.05% in females and was maximum on the right side 50.98%. Occurrence of another frequency was on lies in between the upper 1<sup>st</sup> & 2<sup>nd</sup> premolar tooth at 25.42% in males and was maximum on the left side at 30.50% whereas on the right side was 20.33%. And 23.52% in females and was maximum on the right at 25.49% whereas on the left was 21.56%. In line with 2<sup>nd</sup> premolar 18.64% in males and 16.66% in females and was maximum on the left side at 25.49% (table 5). A total of 250 IOFs where 30 sides were found edentulous. **Conclusion:** The results of this study may be useful to practioner when using the suborbital nerve block for a variety of ways to localize the suborbital foramen.

## INTRODUCTION

The infraorbital foramen IOF is situated bilaterally on the anterior surface of maxillary bone around one cm lower than the infraorbital margins. The infraorbital artery, vein, and nerve are passes through the infraorbital foramen. The infraorbital nerve is an extension of maxillary division of the trigeminus nerve. It travels through an infraorbital fissure, infraorbital groove, or canal and exists from the infraorbital foramen, and appears on the face as an

infraorbital nerve, it is a pure sensory nerve. Finally, the infraorbital nerve terminates into various branches that provide sensory innervation to the lateral aspect of the nose, cheek, labial gum, upper lip, lower eyelid, skin, and mucous membrane.<sup>[1]</sup>

The knowledge of the accurate situation of the infraorbital foramen is necessary for several clinical and surgical procedures like as an infraorbital nerve block, acupressure, and maxillofacial surgical procedures,<sup>[2,3]</sup> and thus the precise location of infraorbital foramen has been the matter of attention of many scientists.<sup>[4-6]</sup>

Provincial blockade of the infraorbital nerve is a frequently used procedure for the treatment of trigeminal neuralgia and surgery of the midface. But a variation of an infraorbital nerve due to the occurrence of an additional infraorbital foramen can affect the infraorbital nerve block and treatment around the midface.<sup>[7]</sup> The other authors stated that the occurrence of an accessory IOF varies extending from 16.9% to 47.6%.<sup>[7,8]</sup>

Therefore, surgeons would be knowing of the probable incidence of this accessory infraorbital foramen from where an accessory infraorbital nerve runs through, surgeons must be confirmed the successful administration of the anesthetic agent's successful treatment of trigeminal neuralgia.

**Aims and objective:** Our study aimed to find out the frequency of variation in distance of IOF, dimension, shape, and location, the direction of the foramen, incidence of the accessory foramen, position of IOF concerning the alveolar margin of upper maxillary tooth and supraorbital foramen or notch from several important anatomical structures on both sides of similar skulls. The result of the present study was compared to the other author's results. The study placed on the palpable point which could be used uniformly in the situation of edema in the region of IOF.

## MATERIALS AND METHODS

105 (One hundred twenty-five) adult human dry skulls of males and females of unidentified age were carefully chosen from the department of Anatomy, from the different medical colleges of north India. This study was approved by the Institutional Research and Ethics Committee of Shri Guru Ram Rai Institute of Medical And Health Sciences, Patelnagar, Dehradun, Uttarakhand.

### Excluded Criteria

A skull was found to be damaged bilaterally or unilaterally in the area of infraorbital foramen, orbital margin, region of zygomaticomaxillary suture and piriformis aperture are excluded from the study. The total side's studies were 250. The following parameters were evaluated and observations are noted in the collection form by the direct vision method on both sides of skulls whereas the direction of infraorbital foramen was noted to insert a plastic coated single core flexible wire. Each data was confirmed by viewing the observer two or more times.

1. Accessory infraorbital foramen either in one, two, or multiple.

2. IOF lies at the line of supraorbital foramen or notch either lateral, medial, or central.
3. The direction of IOF is either medial, inferomedially, or vertical.
4. The shape of the foramen is semilunar, slit-like, oval, and round.
5. The situation of a foramen in relation to the alveolar margin of the upper maxillary tooth.

## RESULTS

The Round Shape of infraorbital foramen on the right side was 58.82% and 55.88% on left whereas on the both side 62.4%. The oval shape on the right side was 35.29% and 26.47% on the left side whereas on both sides 30.88%. The triangular shape on the right side was 1.47% and 7.35% on the left side whereas on both sides 4.41%. The semilunar shape on the right side was 5.88% and 5.88% on left whereas in both side 5.88%. The Slit-like shape on right was 0% & 0% on left whereas in both sides 0%. Occurrences of single hook shape on right were 5.88% and 4.41% on left whereas on both sides 5.14%. And double hooks are present on right at 1.47% and 0% on left whereas on both sides 0.73% in male skulls. The Round Shape of infraorbital foramen on the right side was 45.61% and 50.87% on left whereas on the both side 48.24%. The oval shape on right was 43.85% and 40.35% on left whereas on the both side 42.10%. The triangular shape on the right side was 1.75% and 5.26% on the left side whereas on both sides 3.51%. The semilunar shape on right was 5.26% and 0% on left whereas on both sides 2.63%. Slit like shape on right 1.75% and 3.51% on left whereas on both sides 2.63%. Occurrences of single hook shape on the right side were 3.51% and 1.75% on left whereas on both the side 2.63%. And double hook was present on right side at 0% and 0% on left whereas on both sides 0% in female skulls. [Table 1]

The position of IOF concerning the supraorbital foramen or notch on the right side was 80.88% lateral to SOF, on left 72.06% and 76.47% on the both side. Central to SOF on right side was 10.29%, on left 22.06%, then on both sides 15.44%. Medial to SOF on right side 8.82%, on left 7.35%, and on the both side 8.09% in male skulls.

Lateral to SOF on right side was 73.68%, on left 68.42%, and both sides 71.05%. Central to SOF on right side was 12.28%, on left 26.31%, and on both sides 18.42%. Medial to SOF on right side was 12.28%, on left 3.51%, and on the both side 7.89% in female skulls. [Table 2]

**Table 1: Shape of IOF in male and female skulls in percentage.**

Gender	Male(n=68)			Female(n=57)			M & F(n=125)		M & F Rt.&Lt. (n=250)
	Rt.Side	Lt.side	Both (n=136)	Rt.Side	Lt.side	Both (n=114)	Rt.Side	Lt.side	
Round	58.82%	55.88%	62.4%	45.61%	50.87%	48.24%	52.8%	53.6%	53.2%
Oval	35.29%	26.47%	30.88%	43.85%	40.35%	42.10%	39.2%	32.8%	36%
Triangular	1.47%	7.35%	4.41%	1.75%	5.26%	3.51%	1.6%	6.4%	4%
Semilunar	5.88%	5.88%	5.88%	5.26%	0%	2.63%	5.6%	3.2%	4.4%

Slit like	0%	0%	0%	1.75%	3.51%	2.63%	0.8%	1.6%	1.2%
Single hook	5.88%	4.41%	5.14%	3.51%	1.75%	2.63%	4.8%	3.2%	4%
Double hook	1.47%	0%	0.73%	0%	0%	0%	0.8%	0%	0.4%

**Table 2: Position of IOF in relation to the supraorbital foramen or notch in male and female skulls in percentage.**

Gender	Male			Female			M & F		M & F
	Rt.Side (n=68)	Lt.side (n=68)	Both (n=136)	Rt.Side (n=57)	Lt.side (n=57)	Both (n=114)	Rt.Side (n=125)	Lt.side (n=125)	Rt.&Lt (n=250)
Central to SOF	10.29	22.06	15.44	12.28	26.31	18.42	11.2	24	17.6
Lateral to SOF	80.88	72.06	76.47	73.68	68.42	71.05	77.6	70.4	74
Medial to SOF	8.82	7.35	8.09	12.28	3.51	7.89	10.4	5.6	8

**Table 3: Presence of accessory IOF in male and female skulls in percentage.**

Gender	Male			Female			M & F		M & F
	Rt.Side (n=68)	Lt.side (n=68)	Both (n=136)	Rt.Side (n=57)	Lt.side (n=57)	Both (n=114)	Rt.Side (n=125)	Lt.side (n=125)	Rt.&Lt. (n=250)
One	5.88%	2.94%	8.82%	7.01	5.26	12.28%	6%	4%	9.6%
Two	0%	0%	0%	1.75%	1.75%	3.50%	1.6%	1.6%	0.8%
Multiple	0%	0%	0%	0%	0%	0%	0%	0%	0%

Occurrences one AIOF on right side 5.88%, on left 2.94%, and on the both side 8.82% in males and in females on right side 7.01%, on left 5.26% and on the both side 12.28%. Double AIOF 0% in male skulls and 3.50% in female skulls. Multiple AIOF were not found in any skulls.

**Table 4: Direction of an infraorbital foramen in male and female skulls in percentage.**

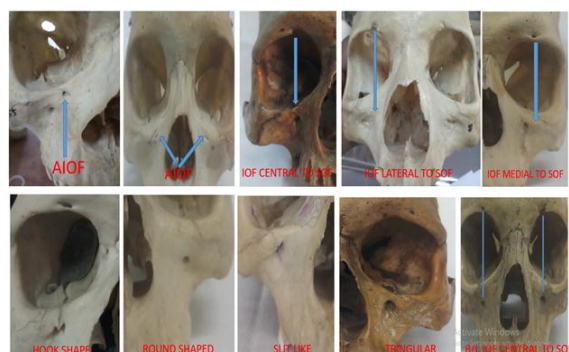
Gender	Male			Female			M & F		M & F
	Rt.Side (n=68)	Lt.side (n=68)	Both (n=136)	Rt.Side (n=57)	Lt.side (n=57)	Both (n=114)	Rt.Side (n=125)	Lt.side (n=125)	Rt.&Lt. (n=250)
Medial	7.35%	7.35%	7.35%	12.28%	12.28%	12.28%	4.8%	4.8%	7.2%
Infero medially	66.17%	60.29%	63.23%	68.42%	64.91%	66.66%	67.2%	62.4%	64.8%
Vertical	25%	29.41%	27.20%	19.29%	29.82%	24.56%	22.4%	29.6%	26%

The direction of infraorbital foramen inferomedially on right side was 66.17%, on left 60.29%, and on, both sides 63.23%. Vertically on right side 25%, on left 29.41%, and on the both side 27.20%. Medially on right side 7.35%, on left 7.35%, and on the both side 7.35% in male skulls.

Inferomedially on right side 68.42%, on left 64.91%, and on the both side 66.66%. Vertically on right side 19.29%, on left 29.82%, and on the both side 24.56%. Medially on right side 12.28%, on left 12.28%, and on both sides 12.28% in female skulls.

**Table 5: Site of IOF in correlation to the upper maxillary tooth in percentage.**

Gender	Male			Female			M & F		M & F
	Rt.Side (n=59)	Lt. side (n=59)	Both (n=118)	Rt.Side (n=51)	Lt. side (n=51)	Both (n=102)	Rt. Side (n=110)	Lt. side (n=110)	Rt.&Lt. (n=220)
IOF-B/W 1 & 2 PM	20.33%	30.50%	25.42%	25.49%	21.56%	23.52%	22.72%	26.36%	24.54%
AT 2 PM	23.72%	13.55%	18.64%	7.84%	25.49%	16.66%	16.36%	19.09%	13.18%
IOF-B/W 2 PM & 1M.	47.45%	47.45%	47.45%	50.98%	43.13%	47.05%	49.09%	45.45%	47.27%
AT 1 Premolar	3.38%	3.38%	3.38%	5.88%	5.88%	5.88%	4.545%	4.54%	4.54%
At 1 molar	1.69%	1.69%	1.69%	3.92%	1.96%	2.94%	2.72%	1.81%	2.27%
IOF-B/W C & 1 PM	3.38%	1.69%	1.69%	5.88%	1.96%	3.92%	4.54%	1.81%	0.90%



**Figure 1:** a shows a single AIOF and 2a double. Figures 3a, 4a, and 5a show IOF central, lateral, and medial to the SOF/notch. Figures 6a, 7a, 8a, and 9a show an oval shape with a hook present, and a round, slit-like triangular shape of IOF respectively. Figure 10a shows IOF B/L central to SOF/notch.

Location of IOF in correlation to upper maxillary tooth the IOF mostly lies in between the upper 2<sup>nd</sup> premolar & 1<sup>st</sup> molar 47.45% in males and the same on the right & left side and 47.05% in females and was maximum on the right side 50.98%. Occurrence of another frequency was on lies in between the upper 1<sup>st</sup> & 2<sup>nd</sup> premolar tooth at 25.42% in males and was maximum on the left side at 30.50% whereas on the right side was 20.33%. And 23.52% in females and was maximum on right at 25.49% whereas on left was 21.56%. In line with 2<sup>nd</sup> premolar 18.64% in males and 16.66% in females and was maximum on the left side at 25.49% [Table 5]. The total 250 IOF where 30 sides were found edentulous.

## DISCUSSION

Veeramuthu M. et al,<sup>[9]</sup> reported the incidence of single AIOF as 9.5% on right side and 11.4% on left side as well as 5.71% on both sides whereas double accessory infraorbital foramen at 3.8% on right side and 1.9% on left as well as 3.8% in both side. The multiple accessory infraorbital foramen is 1.9% on the right and 0.95% on the left in India (Tamilnadu). In the current studies the occurrence of an AIOF in male and female skulls on right 6.4% and the left side 5.6% and 6% in total which was lower than Veeramuthu M. et al.

The site of IOF in correlation to SOF, most of the IOF were lateral to the SOF revealed by Veeramuthu M. et al,<sup>[9]</sup> on right side 58%, on left 72% and C.C. Joseph et al,<sup>[10]</sup> 56.1% and Kharb J. P. et al<sup>(11)</sup> on right side, 73% on left 65% and both side 69.2%. In a present study that was 80.88% on right side, 72.06% on left, and 76.47% on the both side in male skulls where as 73.68% on right side, 68.42% on left and 71.05% on the both side in female skulls and 74% in total skulls.

A large number of the IOF were directed inferomedially as shown by Veeramuthu M. et al,<sup>[9]</sup> on right side at 65.71% and on left at 67.71%, Kharb J. P. et al,<sup>[11]</sup> on right at 86.7%, on left 85%, then both side 85.8%, Elsheikh E. et al,<sup>[12]</sup> in male 78.1% and females 88.9% and Sharma S. et al,<sup>[13]</sup> on right side 66%, on left 56%. In the present studies in males on the sides 66.17%, on left 60.29%, on the both side 63.23%, and in females on right sides 68.42%, on left 64.91%, and on the both side 66.66% and 64.8% in total skulls.

A large number of the IOF were directed inferomedially as shown by Veeramuthu M. et al,<sup>[9]</sup> on right sides at 65.71% and on left at 67.71%, Kharb J. P. et al,<sup>[11]</sup> on right sides at 86.7%, on left 85%, and on the both sides 85.8%, Elsheikh E. et al,<sup>[12]</sup> in male 78.1% and females 88.9% and Sharma S. et al<sup>[13]</sup> on right sides 66% and on left 56%. In the present studies in males on right sides 66.17%, on left 60.29%, and on the both side 63.23%, and in females on right sides 68.42%, on left 64.91% and on the both side 66.66% and 64.8% in total skulls.

The oval shape of the infraorbital foramen was the most common shape mentioned in the literature. Veeramuthu M. et al,<sup>[9]</sup> on right sides 34%, on left 24%, and both sides 29%, Ebogo Messina et al,<sup>[14]</sup> on right sides 52% and on left 44%, Deepthi N. et al,<sup>[15]</sup> on right sides 38% and on left 36% whereas round shape Elsheikh E. et al,<sup>[12]</sup> in male skulls 28.1% and in female skulls 44%, Hong Ji H. et al,<sup>[16]</sup> in male on right sides 65.4%, on left 67.6% and female on right sides 78.8% and left on 80.7%. In the present study round shape were in males 58.82% on right sides, 55.88% on left, and on both sides 62.4%, and in females 45.61% on right sides, 50.87% on left, both side 48.24% and 53.2% on total skulls notice that the Infraorbital foramens was mostly of round shapes on the skull on the both side, shadowed by oval shape.

The position of Infraorbital foramens be situated most common at the 2<sup>nd</sup> pre-molar upper maxillary teeth mentioned in the literature. Gudaji A. et al,<sup>[17]</sup> in males on the right 47.2%, on left sides 47.7% and on the both side 47.4%, and in females on right 54.5%, on left 51.2% and on the both side 52.9%, S. Tewari et al,<sup>[18]</sup> 59.01%, W. Apinhasmit et al,<sup>[19]</sup> in male 59.6% and female 42.6% and 53.8% on both side. In the present study in males on right 47.45%, on left 47.45%, and on the both side 47.45%, and in females on right 50.98%, on the left side 47.5% and both sides 43.13% and a total of 47.2%, found out that the Infraorbital foramens was predominantly lies on 2<sup>nd</sup> premolar upper maxillary teeth in the skulls on both sides, shadowed by 1<sup>st</sup> & 2<sup>nd</sup> premolar teeth.

## CONCLUSION

The results of this study useful to clinical practioner and anesthesiologist when using the Infraorbital nerves Block for a variety of dealings to localize the Infraorbital foramens.

## REFERENCES

1. S. Standring, Gray's Anatomy: Anatomical Basis of Clinical Practice, Churchill Livingstone Elsevier, London, UK, 40th edition, 2008.
2. Hwang K & Baik F. (1999): Surgical anatomy of the orbit of Korean adults. *J. Craniofac. Surg.* 1999; 10(2):129-134.
3. Zide B & Swift R. (1998): How to block and tackle the face. *Plast. Reconstr.Surg.*1998; 101:2018.
4. Kazkayasi M, Ergin A, Ersoy M, Bengi O, Tekdemir I and Elhan A.(2001): certain anatomical relations and the precise morphometry of the infraorbital foramen-canal and groove: an anatomical and cephalometric study. *Laryngoscope.* 2001; 111: 609-614.
5. Leo JT, Cassell MD, Bergman RA. (1995): Variation in human infraorbital nerve, canal and foramen. *Ann. Anat.* 1995; 177:93-95.
6. Wolff E. (1954): The bony orbit and accessory sinuses of the nerve. In *The anatomy of the eye and the orbit.*1954; 4th ed. HK Lewis and Co. Ltd., London: 1-29.
7. Shin KJ, Lee SH, Park MG, Shin HJ, Lee AG. (2020): Location of the accessory infraorbital foramen with reference to external landmarks and its clinical implications. *Sci Rep* 2020; 10:8566.
8. Polo CL, Abdelkarim AZ, von Arx T, Lozanoff S. (2019): The morphology of the infraorbital nerve and foramen in the presence of an accessory infraorbital foramen. *J Craniofac Surg* 2019; 30:244-253.
9. M. Veeramuthu, Ravi varman, Shalini, Manoranjitham (2016). Morphometric analysis of infraorbital foramen and incidence of accessory foramen and its clinical implications in dry adult human skull. *Int J Anat Res* 2016, 4(4):2993-3000. ISSN 2321-4287
10. Charly Chacko Joseph, Meril Ann Soman1, Meera Jacob, Rani Nallathamby (2015): Morphometric Variations In Infra Orbital Foramen of Dry Adult Human South Indian Skulls with Its Surgical and Anaesthetic Significance. *International Journal of Health Sciences & Research* (www.ijhsr.org) Vol.5; Issue: 1; January 2015
11. Janghu Poonam Kharb, Samanta Prajna P., Gupta Nirupma (2012): morphometric analysis of infraorbital foramen in dry adult skulls and its surgical relevance. *Journal of Advance Researches in Biological Sciences*, 2012, Vol. 4 (2) 83-87
12. Ezzeddin Elsheikh, Wail Fayeze Nasr, Amal Al Shahat Ibrahim: anatomical variations of infraorbital foramen in dry human adult Egyptian skulls, anthropometric measurements and surgical relevance. *Otorhinolaryngology clinics: an*

- international journal, September-December 2013; 5(3):125-129.
13. Shikha Sharma, Anil Sharma, Chetna Thakur, Bhawani Shankar Modi (2015): anthropometric measurements of infraorbital foramen and its anatomic variations in dried human skulls. *Int J Anat Res* 2015, 3(4):1487-90. ISSN 2321-4287
  14. Messina Ebogo, Ngaba Olive, Edouma Jacques, Fokwa Gislaine, Hassan Daramsis, Kwedi Karl, Tamba Babacar, Ainina Ndiaye (2021) . Anthropometric measurements of infra orbital foramen in a selected Senegalese population; surgical implications. *Advances in Oral and Maxillofacial Surgery* 4 (2021) 100140.
  15. Deepthi Nanayakkara, Roshan Peiris, Navini Mannapperuma and Amal Vadysinghe (2016). Morphometric Analysis of the Infraorbital Foramen: The Clinical Relevance. *Hindawi Publishing Corporation Anatomy Research International* Volume 2016, Article ID 7917343, p. 8
  16. Ji Hee Hong, MD, PhD, Hyung Jun Kim, MD, Jung Hee Hong, MD, and Ki Bum Park, MD, PhD (2022). Study of Infraorbital Foramen Using 3-Dimensional Facial Bone Computed Tomography Scans. *Pain Physician* 2022; 25:E127-E132 • ISSN 2150-1149
  17. A. Gudaji, S. Ali, A. H. Dambatta (2019). Location of the Infraorbital Foramen in Patients Attending Aminu Kano Teaching Hospital in Nigeria: A Three-Dimensional Computed Tomographic Study Review. *DUJOPAS* 5(1a): 32-42, 2019
  18. Tewari S., Gupta C., Palimar V., Kathur S.G. (2018). Morphometric analysis of infraorbital foramen in South Indian dry skulls. *Bangladesh Journal of Medical Science* Vol. 17 No. 04 October'2018. Page: 562-566
  19. Wandee Apinhasmit DDS, Ph.D., Supin Chompoopong MS, Ph.D., Dolly Methathathip DDS, Roengsak Sansuk, Wannapa Phetphunphiphat (2006). Supraorbital Notch/Foramen, Infraorbital Foramen and Mental Foramen in Thais: Anthropometric Measurements and Surgical Relevance. *J Med Assoc Thai*, 2006: Vol. 89 No. 5