The study of normal interorbital distances of Oriental adults: a preliminary report

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Prachya Maglin*** Thawatchai Watanakajorn****


Objective: To establish the normative value of medial interorbital distances in normal Oriental adults.

Setting: Department of Anatomy, Faculty of Medicine, Chulalongkorn University

Subjects: 212 normal Oriental skulls

Design: Descriptive study

Method: Direct measurement of the medial interorbital distance in adult Oriental skulls using a standard caliper (Thorpe caliper) by one individual.

Result: Of 188 adult skulls (> 25 yrs) included in the study, 169 were from men and 19 were from women. Mean IOD was 23.04 ± 2.30 mm (18.0 - 30.0 mm) without statistical difference between sexes.

Conclusions: This is the first study in which IOD the measurement was taken directly from skulls. The mean IOD is smaller than previously reported in Caucasian. There was no sexual difference but the number of female specimens was too small. The data can be used as a baseline by physicians who care for craniofacial patients in Thailand.

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Key words : Interorbital distance, Medial interorbital distance, Bony interorbital distance, IOD, Orbital dimension.

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วัตถุประสงค์: เพื่อศึกษาค่าเฉลี่ยระดับระหว่างผู้สูงอายุในระบบออกก้าวในผู้สูงอายุ ชาวตะวันออก
สถานที่ทำการศึกษา: ภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ตัวอย่าง: กลุ่มตัวอย่างที่มีอายุแต่ละปกติจำนวน 212 ราย
รูปแบบการวิจัย: การศึกษาชี้วัดปัจจัย
วิธีการศึกษา-วัตถุประสงค์: ทำการวัดระดับระหว่างผู้สูงอายุในระบบออกก้าวผ่านขั้นตอนโดยตรง จากโอกาสสุขภาพสูง ใหญ่โดยใช้ชุดการวัดมาตรฐานซึ่งใช้ถือในห้องผ่าตัด (Thorpe caliper)
ผลการศึกษา: คิดเฉลี่ยได้ 20 หลักสูตรสูงสุด (อายุ > 25 ปี) จำนวน 188 ราย เท่ากับ 169 และเป็นหญิง 19 ค่าเฉลี่ย IOD เท่ากับ 23.04 ± 2.30 มิลลิเมตร (18.0-30.0 มม.) โดยไม่พบความแตกต่างระหว่างเพศ
วิเคราะห์และสรุป: เป็นการศึกษาแรกที่วัดค่า IOD โดยตรงจากโอกาสสุขภาพเพียงใช้เป็นข้อมูล พื้นฐานในการวัดกับผู้ป่วยที่มีความพิการแขน ไหล่และสะโพก ซึ่งทำให้การวิจัยการวัด IOD สำหรับการวิจัยใหม่ที่มีความพิการแขนไหล่สะโพก และพยาบาล ค่าเฉลี่ย IOD ค่ากว่าที่รายงานไว้ในข้อต่อนี้ โดยอาจไม่พบความแตกต่างระหว่างเพศที่ต้องกลับคู่กันทั้งทุกที่สรุปว่าข้อมูลนี้มีความแข็งแกร่งที่เป็นประโยชน์อย่างมาก สรุปว่าข้อมูลนี้มีความแข็งแกร่งที่เป็นประโยชน์อย่างมาก
Increasing numbers of craniofacial disorders are being diagnosed in Thailand. Orbital involvement is a common finding, e.g. orbital hypertelorism in Frontoethmoidal Encephalomeningocoele, craniosynostosis syndrome, frontonasal dysplasia, facial clefts. The orbital pathology can influence patients' clinical appearance, treatment, and outcome. The severity must be objectively determined by measured medial inter-orbital distance (IOD) which has been one of the most important measurements among the orbital landmarks of surgical interest. All corrective operations are certainly designed to maintain the patients' IOD as normal into their adulthood. Orbital shape and size are known to vary with ethnic origin so comparisons must be made within appropriate groups. Nevertheless, measurement of the distance has been compared exclusively to normative values analyzed from Western populations. These standards do not fit as Oriental's real reference and may lead to improper reconstruction. Moreover, there has never existed direct skull measurements for IOD in spite of many radiographic studies for normative values made in wide age ranges.\(^{0-7}\) We therefore tried to establish local normative values of IOD, at least in adults, as a baseline.

### Materials and methods

Cleaned-dried identifiable cadaveric skulls from the Department of Anatomy were used in this study. Inclusion specimens were skulls 1) without any congenital anomaly, 2) with intact medial orbital walls, especially lamina papyracea and lacrimal bones, 3) which were identifiable as Orient, and 4) mature (age > 25).

Age and sex of the specimens were determined by the use of forensic anthropology. Skull is one of most reliable skeletal indicator of sex (Table 1), while there are no skeletal clues that allow a specific age such as 12 years or 25\(\frac{1}{2}\) years. Dental development is an important determinant of age in this study for it virtually stops after age 25. Characters of permanent dentition and skull sutures can also differentiate the age ranges with good accuracy.

**Table 1.** Sexual characteristics of the skull.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraorbital ridge</td>
<td>Robust</td>
<td>Gracile</td>
</tr>
<tr>
<td>(ridge above the eyes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occipital protuberance</td>
<td>Robust</td>
<td>Gracile</td>
</tr>
<tr>
<td>(base of skull)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mastoid process</td>
<td>Long, broad</td>
<td>Short</td>
</tr>
<tr>
<td>(bony process behind ear canal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chin</td>
<td>U - shaped, square</td>
<td>V - shaped</td>
</tr>
</tbody>
</table>

Desired measurement was achieved by one individual using a Thorpe caliper normally used in our operating rooms and the scale was read to the nearest 0.1 mm. (Figure 1) Intra-observer, repeated measurement reliability was calculated at \(p < 0.01\) on a randomly drawn sample (20 percent) of skulls before the study.
Figure 1. Thorpe caliper, angled - slide rule type caliper, graduated 0 mm to 80 mm in 1 mm increments and 0 to 3 inches in 1/16 inch increments. Features 3 mm, angled tips and thumbscrew for locking caliper (Padgett Instruments, inc.)

The medial interorbital distance (IOD) is defined as the distance between bilateral dacrions (junction of the frontal, lacrimal, and maxillary bones)\(^{(8)}\)(Figure 2). Measured data was collected, summarized, and analyzed as mean and standard deviation according to sex and age.

### Results

There were 212 available skulls examined in this study and all were oriental. Most were from men (86.3%). 188 skulls were in the adult age range (>25 yrs) and included in this study. (Table 2)

<table>
<thead>
<tr>
<th>Estimated age</th>
<th>Male</th>
<th>Femal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 25</td>
<td>169</td>
<td>19</td>
<td>188</td>
</tr>
<tr>
<td>18-25</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>16-18</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>14-16</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>&lt; 14</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>183</td>
<td>29</td>
<td>212</td>
</tr>
</tbody>
</table>

Mean IOD in adult skulls was 23.04 ± 2.30 mm (18.0 - 30.0 mm). There was no statistical difference of IOD between sexes, 23.20 ± 2.26 mm and 21.61 ± 2.26 mm in males and females respectively (p>0.05). (Table 3)

### Table 3. Mean IOD in 188 skulls

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Femal</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOD</td>
<td>23.20 ± 2.26 mm.</td>
<td>21.61 ± 2.26 mm.</td>
</tr>
<tr>
<td></td>
<td>23.04 ± 2.30 mm.</td>
<td>(18.0 - 30.0 mm.)</td>
</tr>
</tbody>
</table>

### Discussion

Abnormal distance between the bony orbits has been of medical consideration since the recognition of many related diseases that cause hypertelorism or hypotelorism.\(^{(4,9)}\) Measurements based on soft tissue landmarks may reflect soft tissue pathology but not the bone and it is nearly impossible to take them in a
child. Increased soft tissue in the naso-orbital area can create the appearance of "pseudohypertelorism" or telecanthus.

The bony interorbital distance (BIOD) or medial interorbital distance (MIOD) was first defined by Cameron\(^{(10)}\) in dried skulls as the maximum distance between the medial walls of the bony orbits measured at the juncture of the cri
ta lacrimalis posterior with the frontolacrimal suture.

In 1960, Currarino and Silverman\(^{(1)}\) proposed a distance between the dacryons (juncture of lacrimal, frontal, and maxillary bones), as viewed in the postero-
frontal radiograph (Caldwell view), to be an index for
assessing orbital hypertelorism and hypotelorism. This
point has become an accepted reference to later
evaluations. The bony interorbital distance is easy to
obtain and accurate in assessing the degree of orbital
separation. Since then, investigators have reported
normative data of IOD for clinical usage (Table 4).

Costaras et al.\(^{(4)}\) also examined cephalograms
from 100 normal subjects corrected for sex, age, head
width (BIOD/CW index), and radiographic
enlargement. They thus created another database of the
IOD in a normal population from 2-20 years of age.

Such measurements based on conventional
postero-anterior projection and cephalometric radi-
ograms may be useful in the study of normal subjects,
but their utility in pathologic states is questionable.
Another major problem of a conventional film is a
composite of various structures at different planes.
Cephalometric roentgenography is subject to its intrinsic
error and problematic to interpretation. Later imple-
mentation of CT scans therefore obviated those studies by
its more-detailed information. CT scan also provides
associated soft tissue pathology and, if necessary, any
other linear or angular measurements.

IOD increases gradually from newborn to adult
only 8-10 mm. by a number of factors acting
synchronously and in concert. These include: 1) early
enlargement of the neurocranium with passive
growth at the metopic suture; 2) early growth at the
frontoethmoidal suture; 3) anteroposterior cranial base

Table 4. Previous interorbital measurement studies.

<table>
<thead>
<tr>
<th>Radiographic</th>
<th>CT scans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currarino &amp; Silverman 1960(^{(1)})</td>
<td>PA view</td>
</tr>
<tr>
<td>Morin et al. 1963(^{(12)})</td>
<td>PA view</td>
</tr>
<tr>
<td>Hansman 1966(^{(2)})</td>
<td>Waters view</td>
</tr>
<tr>
<td>Siedband 1966(^{(3)})</td>
<td>Waters view</td>
</tr>
<tr>
<td>Costaras et al. 1982(^{(4)})</td>
<td>PA view</td>
</tr>
<tr>
<td>Marin MCC et al. 1988(^{(6)})</td>
<td>PA view</td>
</tr>
<tr>
<td>MaFee et al 1986(^{(5)})</td>
<td>Different CT level</td>
</tr>
<tr>
<td>Waitzman et al. 1992(^{(13)})</td>
<td>5 - mm CT with 1-cm overlap</td>
</tr>
</tbody>
</table>
growth at the sphenethmoidal and sphenofrontal sutures; 4) passive growth at the internasal and
frontomaxillary suture; and 5) bone apposition on the
medial orbital walls with resorption on their underlying
surfaces.\(^{(1)}\) Interorbital growth is 50% completed by
3 years of age\(^{(12)}\) and 85-90% of the normal adult inter-
orbital distance is achieved at 5-8 years of age.\(^{(6,13)}\) The
growth levels off at about 13 years of age in girls and
21 years of age in boys, similar to other areas of
the upper face and midface.\(^{(2)}\) Generally, facial growth
changes minimally after late adolescence (17-20 years
of age).\(^{(13)}\)

It is not ethical to obtain numerous CT scan
from a wide-age range of normal population especially
in children whose congenital diseases are the problems.

Mean IOD in adults reported by different
authors is 22-25 mm. in women and 23-28 mm. in men
(Table 5). The IOD we observed is on the lower limit
of those previously reported. This is not surprising
for Orientals are usually smaller in body size than
Caucasians. Most previously believed the IOD for girls
is narrower than for boys.\(^{(3-5, 12)}\) Our data does not
substantiate this but the number of female skulls in our
study may have been too small to reach the statistical
significance, and there are a few authors contradicting
the difference.\(^{(1, 13)}\) Most specimens derived from
those after accidental events where the imbalance in
sex can be explained by the higher risk men are usually
subject to.

| Table 5. Mean IOD in adults (age > 24) reported by different authors. |
|-----------------|-----------------|----------------|
|                 | Male            | Female         | Number |
| Hansman\(^{(2)}\) | 28.4            | 25.8           | 55     |
| Costaras et al.\(^{(4)}\) | 23.4 +/- 2.5   | 22.0 +/- 1.6   | 28     |
| MaFee et al.\(^{(5)}\) | 26.7 (22.9 - 32.1) | 25.6 (22.9 - 32.0) | 400    |

There has been no direct measurement of IOD from
human skulls in spite of the large collections of
normative data developed by many authors.\(^{(1-5, 11, 12)}\)
Thus, adequate skull specimens from older (> 25 years
of age) normal local people should at least set a local
standard for various diagnostic and therapeutic plans.
Any reconstructive orbital surgery carried out after 5-8
years of age may not result in serious subsequent
growth disturbance. Preferred osteotomy movement
and the orbital anatomical position, IOD, can then be
planned to match the closest margin of proper
appearance in the future.

Conclusion
This is the first study in which the measure-
ment of the IOD was taken directly from the skull
specimens. The purpose was to begin to establish local
normative data for the interorbital distance. In the study
it was determined that Oriental IOD's are smaller than
those measured in Caucasians but there was no
difference between men and women. As specimen
collection expands and there is a suitable balance in
sex and age ranges, the resulting quantitative data
should have clinical use to those who care for patients
suffering with abnormal configurations in Thailand.
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