



## Original communication

## Reliability of mandibular canine and mandibular canine index in sex determination: A study using Uyghur population



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## ABSTRACT

Sex determination is a key process that is required to establish the forensic profile of an individual. Mandibular canine index (MCI) method yields fairly positive results for sex determination. However, this method has been challenged by a few authors. This study aimed to examine the reliability of MCI in Chinese Uyghur population and to establish its normal value for this ethnic group. Dental casts of 216 students (117 males and 119 females) from the College of Stomatology of Xinjiang Medical University in China were used to determine the sexing accuracy of MCI. The mesiodistal (MD) dimension of mandibular canine crowns, the inter-canine distance, and the MCI were calculated. The accuracy of the standard MCI derived from the current data was compared with that of the standard MCIs derived from previous data. Results were statistically described using the independent-samples *t*-test. The MD dimension of mandibular crown, the inter-canine distance, and the MCI exhibited statistically significant sexual dimorphism. Sex determination using the MCI derived from the current data revealed fairly reliable results. Therefore, MCI is a reliable method for sex determination for Uyghur population, with 0.248 as standard MCI value.

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## 1. Introduction

Sex determination is a key process in forensic medicine and archeology. Besides age, race, and stature determination, sex determination is crucial in establishing the forensic profile of an individual. Many studies have applied different techniques to correctly identify the sex of an individual, particularly in post-mortem cases. Among these techniques, DNA examination is regarded as an accurate and reliable method; however, some factors, such as operation complexity and high cost due to difficult extraction of nuclear DNA from degraded samples,<sup>1</sup> render DNA testing as a last resort. Anthropological measurements on the skull and pelvic bones are useful for sex prediction in forensic cases.<sup>2,3</sup> However, recovering severely damaged and mutilated corpses, particularly in massive disasters, may limit measurements on cranial and pelvic bones. By contrast, odontometric analysis may be a good adjunct in such situations because teeth and jaws are frequently intact when recovered.<sup>4,5</sup>

Teeth are strong anatomical structures that can withstand various insults, such as thermal and bacterial decomposition; thus,

teeth have become increasingly important for addressing forensic concerns.<sup>6</sup> Mandibular canines are the first choice in odontometric analysis because these teeth demonstrate high resistance to periodontal diseases and traumatic insults. Mandibular canines erupt at an early age (10.87 years old).<sup>7</sup> Recent studies found a significant relationship between the development of mandibular canines and skeletal maturation, which also showed the difference in both genders.<sup>8</sup> Based on their significant sexual dimorphism, mandibular canines are considered as “key teeth” for sex determination.<sup>9,10</sup>

Rao et al.<sup>11</sup> originally studied the use of mandibular canines and developed the mandibular canine index (MCI). Many researchers using this index have also obtained fairly positive results. Consequently, the MCI has become an increasingly popular criterion in sex determination because of its simplicity, quick results and high accuracy.

Controversies regarding this index emerged when a few studies proved that MCI is practically unreliable. Some researchers questioned the reliability of MCI and revealed that this index was not sufficiently sensitive.<sup>12,13</sup> Even the reliability of mandibular canines in odontometric analysis was questioned in a recent study.<sup>14</sup>

Therefore, the current study aimed to determine the reliability of mandibular canines and MCI for addressing forensic

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concerns in the Chinese Uyghur population. The Uyghur population was used in this study for the following reasons. The Xinjiang Uyghur Autonomous Region is located in northwest China and shares 5500 km of international borders with Mongolia, Russia, Kazakhstan, Kyrgyzstan, Tajikistan, Afghanistan, and Pakistan. The region lies in the heart of the ancient Silk Road, which has historically experienced the migration of several groups of Eastern and Western Eurasians.<sup>15</sup> Modern Uyghurs who are traditionally a nomadic population evolved over time from many clans and tribes; they are currently the major ethnic group in Xinjiang based on the population size. Given the historical demographic patterns in Xinjiang, the characterization of paternal genetic variation of these major ethnic groups is important for establishing representative forensic reference population databases for this region. Another research purpose here was to establish a normal value of standard MCI for this particular ethnic group.

## 2. Materials and methods

### 2.1. Sample

This study involved students of the First Affiliated Hospital of Xinjiang Medical University in Urumqi, China. All the selected

$$\text{Standard MCI} = \frac{(\text{Mean male MCI} - \text{S.D.}) + (\text{Mean female MCI} + \text{S.D.})}{2}$$

students belonged to the Uyghur population. Out of the total pool of 3420 students, 216 individuals (107 males and 109 females) were selected based on the following inclusion and exclusion criteria. The age range of the selected students was 18–25 years old.

#### Inclusion criteria:

- Chinese (Uyghur) ethnicity
- Healthy gingival tissue and periodontium
- Caries-free mandibular canines
- Normal molar and canine relationships (Angle's Class-I molar and canine relationship)
- Normal overjet and overbite relationships (2 mm–3 mm)

#### Exclusion criteria:

- Ongoing or completed orthodontic treatment
- Crowding of the anterior teeth
- Spacing in the anterior teeth

Informed verbal consent was obtained from each participant. Dental impressions of the participants were obtained with a non-reversible hydrocolloid (alginate) material, and dental stone was poured into these impressions to form casts.

## 3. Methods

The following parameters were determined in both male and female casts:

- Mesiodistal (MD) dimension of mandibular canines
- Mandibular inter-canine distance

The MD dimension of mandibular canines was measured as the maximum distance between the contact points on the approximate surfaces of the tooth crown.<sup>16</sup> The inter-canine distance was measured between the tips of both mandibular canines. Both measurements are shown in Fig. 1. In case of a worn mandibular canine tip, the measurement was conducted using the buccal ridge of the canine crown because it intrinsically corresponds to the canine tip.<sup>12</sup>

A digital caliper with a minimum calibration of 0.01 mm (Guanglu measuring tool factory, China) was used to record all the measurements. All measurements of dental casts were repeated by two examiners in order to test the reliability. The MD dimension of mandibular canines and the mandibular inter-canine distance were statistically examined to check the inter-observer and intra-observer reliability using intra-class correlation coefficient analysis. The observed MCI was calculated using the following formula<sup>11</sup>:

$$\text{Observed MCI} = \frac{\text{Mesiodistal mandibular crown width}}{\text{Mandibular inter - canine}}$$

The standard MCI value was calculated using the following formula<sup>11</sup>:

The standard MCI value served as a cut-off point to differentiate males from females. Individuals with the observed MCI values less than or equal to the standard MCI value were categorized as females; otherwise, they were categorized as males. This approach is a simple and rapid means of sex determination.<sup>12</sup> The measurements used to calculate the standard MCI were obtained from the same study population.

The accuracy of the standard MCI, to correctly identify the gender, was statistically determined by receiver operating characteristic (ROC) analysis. ROC curve is a graphical plot that is used to interpret the sensitivity and specificity of a diagnostic test. The curve is created by plotting the true positive rate against the false positive rate at various threshold settings. The true-positive rate is also known as sensitivity in biomedical informatics. The false-positive rate is also known as the fall-out, which can be calculated as 1 – specificity. The ROC curve is thus the sensitivity as a function of fall-out.<sup>17</sup> The area under the curve (AUC) determines the accuracy of the test. An AUC value of 1.0 indicates the perfect test, i.e., perfect sensitivity and perfect specificity. If the AUC is 0.9–1.0, it shows excellent test. An AUC value of 0.8–0.9 shows a good test, whereas an AUC value of 0.7–0.8 depicts a fairly reliable test. The AUC value less than 0.5 indicates an unreliable test.

The standard MCI derived in the present study was compared with the standard MCI derived in previous studies by applying all MCI values to the current sample in order to examine the effect of the difference in population on sex determination accuracy.

The MD dimension of mandibular canines, the inter-canine distance, and the arithmetic calculations for deriving the standard MCI, and their sexing accuracy were collected in an MS Excel spreadsheet (Microsoft Corp., 2010). All statistical analyses were performed with SPSS 17.0 software package (SPSS Inc., Chicago, IL, USA).

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