Original Article - Evaluative Study

Prevalence and Severity of Mandibular Asymmetry in Non-Syndromic, Non-Pathological Caucasian Adult

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Abstract

Background: Mandibular Asymmetry has been analysed in diverse, non-Caucasian groups, principally children. No large-scale analysis has been carried out on non-syndromic Caucasian adults. **Aims:** To evaluate the prevalence and severity of mandibular asymmetry; to identify gender differences and evaluate side predominance, where no actual patient concern was reported and no surgery was being contemplated. **Materials and Methods:** Dental records of 437 patients were analysed. This large patient cohort had no reports of pathology involving the rami or condyles or the TMJ. Following strict 'Inclusion Criteria', 200 DPTs were analysed: 96 male, 104 female patients (age range 18-93 years, average 59.41 years, SD ±13.94). **Statistical Analysis:** Intra-observer error was determined, r = 0.99. The Student t-test determined differences between the sides for ramal height measurements. and gender. The Asymmetry Index evaluated the severity of asymmetry between condylar heights and ramus. **Results:** 18 % of the cohort presented substantial Mandibular Ramal Asymmetry (MRA). Male prevalence was 23.9%; female prevalence was 12.5%; severity was 18.82% and 32.88% respectively. **Conclusions:** Incidence of asymmetry, though significant, has no detrimental effect on the patient's well-being or dental health. Facial surgery that is contemplated in response to both minimal and extreme asymmetry may well be carried out as a result of other cultural demands.

Keywords: Mandibular asymmetry, orthognathic surgery, prevalence, severity

Introduction

One role of orthognathic surgery is the "correction" of facial features to enhance function and aesthetics.[1] Esthetic goals are said to include (mathematical) mirrored symmetry, or "a state of balance" between contralateral sides of the face involving size, shape, and morphology of facial hard and soft tissues. Craniofacial structures on either the left or right side of the median sagittal plane have a visible similarity to the other side, so resulting in pleasing esthetics.[2]

Observational studies[3,4] in children have demonstrated that asymmetry rather than symmetry is the norm. Melnik's[4] study on 200 growing "White" children demonstrated that mandibular asymmetry occurs and changes in severity throughout a normal growth range of 6–16 years of age, concluding that there are a gender difference and an age difference in the rate of growth of the mandible. Further, there is equal likelihood of that difference "improving" or worsening. Liukkonen *et al.*[3] then stated that asymmetry generally has no clinical significance and may not be readily visible. Nevertheless, where that asymmetry is large, clinical problems may result.

Sperber[5] noted that asymmetries of the mandible may cause functional difficulties in the stomatognathic complex. Mandibular growth is via endochondral ossification with the condylar cartilages providing the major growth factors in the generation and remodeling of bone. Normal mandibular spatial positional changes are downward and forward, with asymmetrical growth and consequent dissimilar mandibular, or gonial angles effecting facial appearance.[6] Treatment of prognathism, whether bilateral or unilateral,[7,8] involves reduction of the gonial angles. Disturbances to the condylar cartilages, via injury, infection, or radiation damage, may instigate asymmetry.

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Syndromic mandibular asymmetry has been researched: asymmetry may result from osteoarthritis, rheumatoid arthritis,[9] and degenerative joint disease.[10,11] In addition, sucking habits and mouth breathing have been associated with dimensional variations in the structure of the mandible.[12,13] Where the temporomandibular joint suffers internal derangements in degenerative joint disease, Kambylafkas *et al.*[14] suggest that skeletal morphology may be altered. Shortened rami, steeper mandibular plane angles, and cranial base involvement have all been reported to produce disk displacement together with rheumatoid arthritis.[15] Interarch cross-bites have been implicated in mandibular asymmetry, with Class III and Class II/Division 1 skeletal relationships dominating. In a multi-ethnic Asian population, asymmetry was found in 48% of skeletal Class III cases, of which 84% underwent bimaxillary surgery.[16] Similarly, in a Japanese population, up to 85% of patients with a skeletal Class III malocclusion had facial asymmetry with deviation of the midline structures.[17]

The panoramic radiograph provides a technique to investigate the various parts of the mandible independently on the right and left sides.[5,18,19] In view of the lack of information recorded for adult Caucasians with respect to mandibular asymmetry, a retrospective study was established to evaluate the degree and prevalence of mandibular ramal asymmetry (PMA) occurring in a large population of Caucasian adults in a South England urban population requiring advanced restorative treatment; to identify possible gender differences; and to evaluate side dominance of mandibular ramal asymmetries (MRAs), where no patient reported concern with facial asymmetry.

Materials and Methods

Dental records of 437 self-described Caucasian patients who had undergone extensive, advanced restorative dental treatment were analyzed with the object of discovering appropriate dental pantomogram (DPT) radiographs. DPT radiographs were found in 364 patient records; all were scrutinized by the "inclusion criteria:"

- The entire mandible must be fully captured with no positioning errors on the radiograph
- No exposure or processing faults-film contrast being satisfactory for all intended measurements
- No artifacts, which could affect the planned measurements.

Two hundred DPT radiographs were considered suitable for measurement [Figure 1]: 96 male and 104 female patients, age range 18–93, mean age 59.41 years, standard deviation ± 13–94. Using the Apparatus Fiad Strato *X* (Villa Sistemi Medicali, Viterbo, Italy), all films had been exposed at 68–70 kV and 12 mA, controlled by the same operator (SM), using a standard panoramic program. Images were captured on Kodak T-Mat (Carestream Dental, Stevenage, UK) dental films.

Following a pilot study by two calibrated examiners (MT, SM), both having specialized training in radiology, measurements were determined on schematic diagrams, and detailed start and end points of the measurements were clarified between those investigators. A single examiner (MT) subsequently performed all measurements.

Ramal height measurement[3,14] was based on tangential lines parallel to the ramus and to the body of the mandible. Under ×5 magnification, requisite lines were drawn on tracing paper for measurement [Figure 2]. The measurements were taken to an accuracy of 0.01 mm (100-mm Digital Vernier Caliper, Maplin Electronics, UK). All radiographs were remeasured in the same manner after a 4-week interval.

Statistical analysis

The intraobserver error was statistically calculated for reliability ($r = 0.99$).

Age and gender were recorded [Figures 1 and 3]. Data were recorded in Microsoft Excel. The Student's *t*-test was used to determine differences between the sides for ramal height measurements,[20] and to compare gender [Table 1].

The asymmetry index (AI)[19,21] was used to evaluate the severity of asymmetry between heights of both sides of the ramus of the mandible:

$$AI, \% = RRH - LRH/RRH + LRH \times 100 = R - L/R + L \times 100\%.$$

Where RRH = right ramus height; LRH = left ramus height. Positive AI values indicated that the right mandibular ramus was longer; a negative AI indicated an elongated left side.

Observed asymmetries exceeding 3% AI, which equals 6% of dimensional difference between contralateral sides, indicated vertical asymmetries between the mandibular rami. Thus, 3% AI was taken as a border value-only the data beyond this borderline were used in the final evaluation for this study [Figure 3].

Results

Our null hypothesis stated, "no statistically significant differences would exist between the average values of two measurements obtained for the right and left RVD for both genders in the population under investigation;" the level of significance used being $P < 0.01$.

Statistically significant differences existed between the sides of the mandible for RVD measurements, in both male and female groups [Table 1]. Thus, the null hypothesis was rejected.

The AI showed a significant asymmetry exceeding 3% AI threshold level in both genders. The results showed that 18% of the whole sample presented significant asymmetry when comparing both sides of the mandible [Table 2]. Again, the null hypothesis was rejected.

There was a difference in PMA between genders: 23.9% men and 12.5% of the females presented noteworthy asymmetry, exceeding 3% of AI [Figure 3]. The positive AI value indicated right side dominance.

The intensity of ramal asymmetry in the whole group (where AI >3%) was at the level of 24.23% of SMA [Table 2]

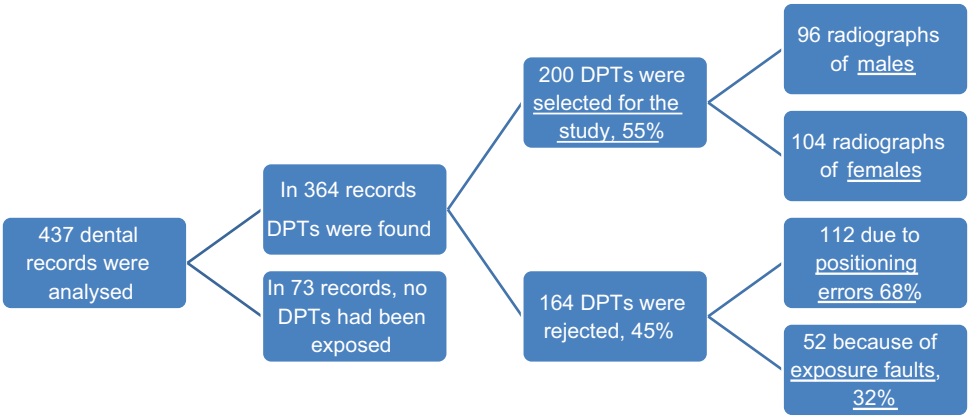

Figure 1: Flow-chart illustrating the process of radiograph selection for the study

Age analysis	Years
Range	18-93
Mean±SD	59.41±13.94

SD=Standard deviation

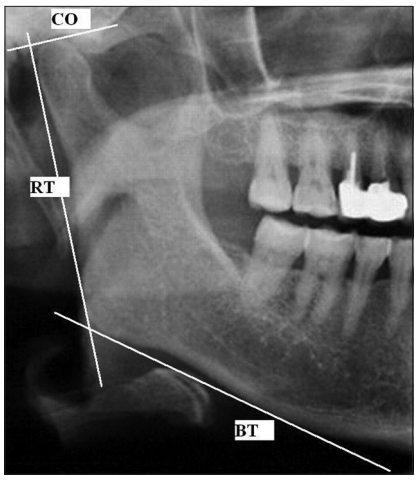

Figure 2: Reference points for measurement. The tangential line to the body BT; the tangential line to the ramus RT and the perpendicular line from the ramus tangent to the higher part of the condylar head CO were drawn. Intersection of lines CO and RT produced the upper reference point. Intersection of lines RT and BT set up the lower reference point. The vertical distance from upper reference point to lower reference point on the ramus tangent represented the Ramal Vertical Dimension or ramus height

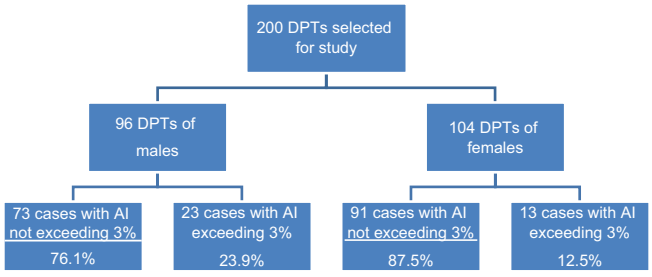

Figure 3: Distribution of incidence of asymmetry index <3%, and asymmetry index >3%

with a substantial difference between sexes. The SMA value, calculated on the basis of average total AI and PMA in the group in question, was 18.82% for males, corresponding to 32.88% for females [Table 2 and Figure 4].

Where A1 >3%, the right mandibular ramus was longer for both men and women, with 84.6% of men and 78.3% of women presenting right mandibular ramus dominance [Table 2].

Discussion

Both Athanasiou *et al.*[22] and Habets *et al.*[19] proposed panoramic radiography as suitable for measuring both condylar and total ramal heights when the aim is to define differences in the right- and left-sided mandible dimensions. Variations in head positioning do not affect vertical dimensions while horizontal dimensions do. Figure 5 shows the tangential lines on cases used in this study to gain the measurements of the left and right ramal heights. Of particular note, to help justify the acceptance of the accuracy and reproducibility of the vertical measurements of the condyle and ramus, this present paper shows two of the cases used with subsequent panoramic radiographs taken within a treatment period – the vertical dimensions that have been recorded are reproducible on each radiograph: This is the proof of principle [Figure 6].

Habets *et al.*[19] concluded that "if a 6% vertical difference can be detected between the right and left sides of a panoramic radiograph, it should be noted" as unusual and should be regarded as indicating "asymmetry."

Some reports of mandibular asymmetry in the literature have not compared gender differences because of limited sample sizes.[15,16,23] Other reviews of the vertical condylar and ramal asymmetries in which sex differences were also investigated found no significant differences.[6] Our results do not agree with those findings. Other research papers do agree, but great caution needs to be exercised with these, because of differences

Table 1: *P* calculation with paired *t*-test for the average right and left ramus height for males and females; performed to test statistical significance of collected data

	Males, 96		Females, 104	
	Average right RH	Average left RH	Average right RH	Average left RH
Mean±SD	82.14±6.06	80.75±6.33	72.27±5.25	70.87±5.26
P-value of paired *t*-test		0.001		0.0001

RH=Ramus height; SD=Standard deviation

Table 2: Percentage incidence of prevalence and severity of mandibular asymmetry for the cohort

	AI value		
	Males, 96	Average of both genders	Females, 104
Prevalence PMA (%)	23.90	18	12.50
Average of total AI	4.5	4.36	4.11
Severity SMA (%)	18.82	24.23	32.88
Right ramus domination (%)	84.6	80.5	78.3

AI=Asymmetry Index; PMA=Prevalence of mandibular ramal asymmetry; SMA=Severe mandibular asymmetry

in patient selection criteria and age groups.[5] Based on our findings, a significant degree of asymmetry between right and left ramus of the mandible can be expected in a nonsyndromic, nonpathological adult Caucasian cohort.

We identified significant asymmetry of ramal height between the right and left sides for both sexes. In addition, the difference in occurrence and intensity of the MRA was noteworthy between the sexes.

The incidence of MRA over 3% between sides was higher for men at 23.9%, when compared to 12.5% for women. However, the magnitude of MRA was greater for women at 32.88% of severity of MRA (SMA), counter to 18.82% of SMA for men. Enhanced occurrence (PMA) of the MRA in males than in females (23.9% opposed to 12.5%) balanced the greater magnitude (SMA) of the MRA in females. Looking only at the average total AI value, one could argue that the difference in SMA between genders was insignificant, which was not the case. The results of this current investigation showed that 18% of the whole group presented a significant difference in vertical dimensions between the right and left mandibular ramus.

The right mandibular ramus was longer in both genders. The dominance of right mandibular ramus was more significant in women (84.6%) versus men (78.3%). Our results agreed with those of Skvarilová,[24] who reported that right side supremacy occurred over the left when the length of both mandibular rami was taken into consideration. Our study did not identify any pathological conditions, which would be associated with substantial MRA. Our results are certainly at odds with Rossi *et al*.,[25] who stated that pathological conditions were likely to be associated with the considerable MRA. Thus, in our investigated sample of White adult patients, the significant degree of RMA did not affect the treatment planning and the clinical approach.

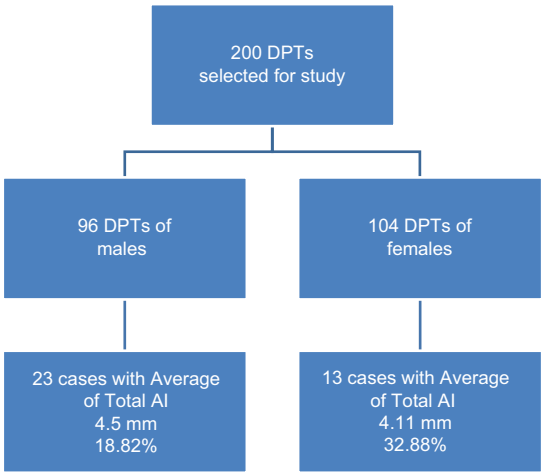

Figure 4: Incidence of severe mandibular asymmetry

Figure 5: Radiograph with tracings for Case 46 (female). The lines as shown in Figure 2 have been drawn and measured. With this information the asymmetry index, it was calculated as 4.09

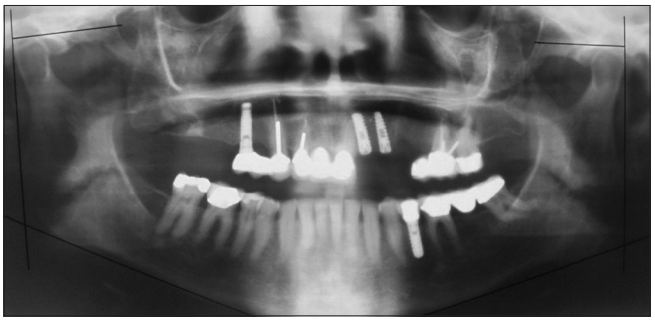

Figure 6: Radiograph with tracings for Case 43 (female). The lines as shown in Figure 2 have been drawn and measured. With this information the asymmetry index, it was calculated as −3.26

Conclusions

Previous studies that have investigated the prevalence and incidence of mandibular asymmetry were all carried out on patients presenting with recorded sagittal defects, pathology, and syndromes or were young children or developing adults, with a predominance of specific ethnic cohorts. A paucity of information exists for a large nonsyndromic adult Caucasian cohort. Our study confirmed a high PMA in this sample of healthy, nonsyndromic adult Caucasian patients. The results showed gender-related differences in the PMA and SMA: 18% of the cases in the cohort presented substantial MRA. The prevalence was recorded at levels of 23.9% among the male group and 12.5% among the females; severity was at the level of 18.82% and 32.88%, respectively.

We have shown that asymmetry is highly prevalent for both genders with male prevalence being dominant but the female being more severe for a large Caucasian cohort. However, of note, this examined cohort had no reported or discovered pathologies; therefore, it can be postulated that the incidence of asymmetry, though significant, has no detrimental effect on the patient's well-being or dental health and that facial surgery that is contemplated in response to both minimal and extreme asymmetry may well be carried out partially as a result of other cultural demands.

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Conflicts of interest

There are no conflicts of interest.

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