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The use of radiographs for assessment of asymmetric growth in mandible with AAI. One patient's view report

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Summary

Background: The indices of asymmetry enable estimation and long-term control of mandibular growth.
The aim of this study is to present 3 indices which have been used in case of atypical growth of left and right part of mandible.

Material/Methods: Radiograms in PA projection, panoramic views and CT scans of patient KK, aged 24, were used in this study. Comparative measurements and calculations of Habets index, Kjellberg index and own, angular asymmetry index (AAI) were performed.

Results: The analysis of left mandibular condyle and ramus showed severe anatomical deviations. Comparative evaluation of panoramic views allowed to observe progression of lesions responsible for asymmetry.

Conclusions: Indices of asymmetry are objective method of mandibular growth estimation. Because of different gauge points and different way of calculation, presented indices: Habets, Kjellberg and AAI are incomparable, but each of them may be used as sufficient diagnostic tool. The angular asymmetry index (AAI) seems to be the simplest and quickest of all three.

Key words: asymmetry • bone diseases • mandible

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Background

Bone diseases of maxillofacial region occured by asymmetry are difficult to diagnose. That group includes undoubtedly: fibrous dysplasia, cherubism, osteogenic fibroma, cementoblastoma, neoplasms (osteosarcoma, osteoblastoma), Paget disease, Reclinghausen disease, inflammatory conditions of bones, and idiopathic unilateral hyperplasis of mandible. [1–4]. The cause of diagnostic difficulties of jaw asymmetry is various, often unknown etiology of lesions. It's a problem to determine whether asymmetry is caused by mandibular growth center anomaly or by bone disease. The aim of this study is to present application of asymmetry indices. On example of female patient KK, aged 24, chart no 94/03, with excessive asymmetric growth of left and right side of mandible usefulness of three indices was presented.

Material and Methods

Facial asymmetry of unknown etiology was the main reason of visit in Department of Orthodontics (Pomeranian Medical University in Szczecin – PMU) for 16 patients. After clinical and radiological examination in 7 cases abnormal bone structure of mandible was diagnosed and further observation and investigations were recommended. Described female patient – KK, aged 24, was one of them. Magnitude of asymmetry was estimated with methods developed by Habets, Kjellberg [5,6] and by authors of this paper. Application of all three indices has been explained on example of patient KK. Skull radiograms in PA projection, panoramic views and computed tomograms of the patient were analyzed. The patient was seen for the first time in Department of Orthodontics PMU in year 2003 because of malocclusion, facial asymmetry, mastication and speech abnormalities. The anamnesis revealed that patient had noticed first symptoms in year 2001. She complained of mastication, swallowing, respiration and speech disturbances, as well as pain in left temporomandibular joint. During first visit radiological examinations were performed: panoramic view, lateral cephalogram (right profile) and skull in PA projection. All radiograms demonstrated asymmetric structure of mandible within body, ramus and

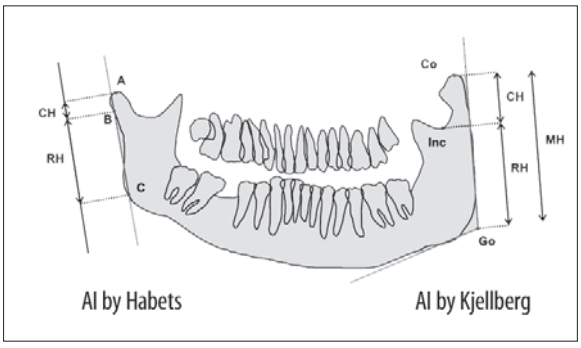

Figure 1A. Figure on basis of panoramic view – year 2003. The measurement of A-B and A-C distance according to Habets. The measurement of mandibular condyle and ramus lenght according to Kjellberg.

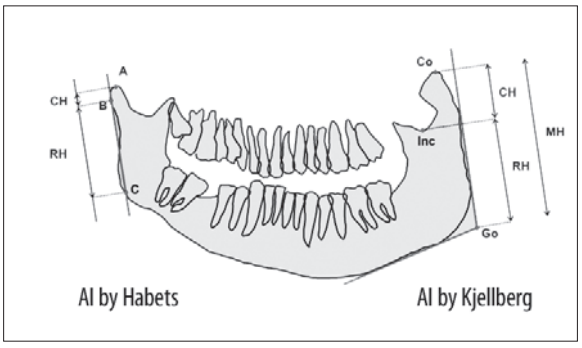

Figure 2A. Figure on basis of panoramic view – year 2006. The measurement of A-B and A-C distance according to Habets. The measurement of mandibular condyle and ramus lenght according to Kjellberg.

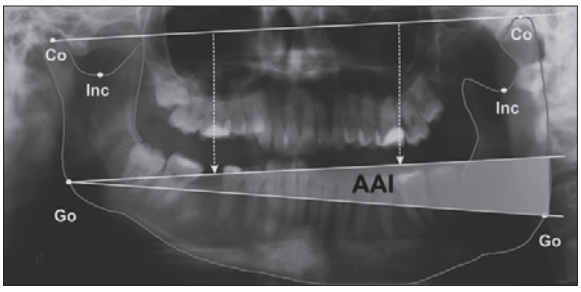

Figure 1B. The panoramic view of patient KK – year 2003. The left condyle is a little deformed in all three dimensions. The measurement of AAI_p and proportion of left and right length of mandible ramus on high Co-Go and Inc-Go.

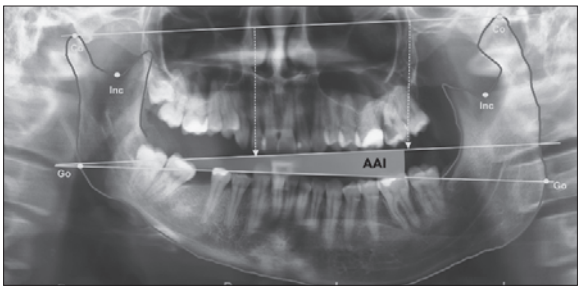

Figure 2B. The panoramic view of patient KK – year 2006. The further, significant deformation of left ramus and corpus mandible. The measurement of AAI_p and proportion of left and right length of mandible ramus on high Co-Go and Inc-Go.

condyle on the left side. Patient was seen again in year 2006 with aggravation of her problems. The same radiological examinations were performed; patient was also referred for CT. On radiograms asymmetry indices according to Habets, Kjellberg and own angular asymmetry index (AAIP on panoramic views) have been calculated and explained (Figure 1A,B; 2A,B; Table 1). Bone material was also collected for histopathological examination, but unfortunately sample was matched too superficially only in cortical bone layer not reaching spongy bone layer, no confirmation of clinical diagnosis of fibrous dysplasia was obtained. To assess differences between right and left sides of mandible Habets index was used; on panoramic views following gauge points were determined: (A) – most superior point on the condyle head, (B) – the most posterior point on condyle contour, (C) – cephalometric anatomical point: gonion (Figures 1A,2A). Index was calculated according to following formula: AI=(R–L)/(R+L)×100%, where: AI – asymmetry index; R – right side values; L – left side values; both dimensions condyle length or ramus length may be used for calculation. According to Habets, difference of dimensions between both sides of mandible exceeding 3% suggests asymmetric relations. Possible error due to incorrect projection on panoramic radiograms should be taken into account. Index developed by Habets allows to detect both right- and left-sided mandibular asymmetry [5]. In order to determine Kjellberg asymmetry index, the following gauge points were marked on panoramic views: Co – Condylion (most superior point on condyle head), Inc – Incisura (lowest point between condylar and coronoid processes of mandible), Go – Gonion (crosspoint of two lines: tangential to ramus and tangential to mandibular body). These points delineate following distances: Co-Inc i.e. condyle height (CH), Inc-Go i.e. height of mandibular ramus without a condyle (MH) and Co-Go i.e. total height of mandibular ramus (RH) (Figures 1A,2A; Table 1). All calculations were performed according to formula: $L=CH_L/CH_L+MH_L\times100\%$ (for left side) and $R=CH_R/CH_R+MH_R\times100\%$ (for right side). Obtained values allowed to estimate size relations between condyles and ramus on both sides of mandible and to identify which of them seems to be responsible for asymmetry [5,6]. Using own modification of asymmetry index (AAI), dimensions of right and left mandibular rami were compared. The angular asymmetry index (AAI) was based on measuring the angle formed by two crossing straight lines connecting anatomical points Co and Go on both sides of mandible (panoramic views – Figures 1B,2B). Distances between anatomical points Co – Go and Inc – Go were measured for metric evaluation of differences in left and right ramus length (Table 2). Figure 3 shows a method of determination of angular index – AAI_{PA} – on a radiogram taken in PA projection. Angular index can also be determined on coronal plane tomograms - AAI_{TK2D}, as shown in Figure 4. In turn, Figure 5 presents determination of angular index on 3D reconstruction based on PA projection – AAI_{TK3D}, obtained by 3D helical (spiral) CT.

Results and Discussion

The analysis of presented asymmetry indices shows marked disproportion in dimensions of left mandibular ramus,

Table 1. The Changes of mandibular ramus dimensions in estimation of asymmetry on panoramic views.

Panoramic view		Vertical dimension according to Kjellberg			Vertical dimension according to Habets	
Year	Side	CH	MH	RH	A-B	A-C
2003	Right	15	49	64	5	64
	Left	28	57	85	6	85
Difference between sides		13	8	21	1	21
2006	Right	17	47	64	6	64
	Left	32	61	93	7	93
Difference between sides		15	14	29	1	29

CH – condyle height; MH – mandibular ramus height without condyle height; RH – mandibular ramus height including condyle height.

Table 2. The Linear measurements on panoramic views for estimation of mandible asymmetry.

Panoramic view		Inc-Go	Co-Go
Year	Side		
2003	Right	48	64
	Left	61	85
2006	Right	48	64
	Left	62	93

with prevailing condylar growth. Comparison of Habets, Kjellberg and AAI indices allow to evaluate extent of asymmetry (Figures 1–5; Table 1,2). Additionally, Kjellberg index describes relation between right and left mandibular condyles. As it follows, source of most significant functional problems seemed to be left condyle, which had changed its shape and filled tightly whole articular fossa. A structure of left condyle and ramus demonstrated considerable abnormalities. Panoramic view from 2003 presents slightly deformed left condylar process in all three dimensions. Next view from 2006 demonstrates further, significant deformation of left-sided part mandible. Comparative analysis of panoramic views allows to assess severity and progression of lesions responsible for asymmetry. Analysis of distances presented in Table 2 indicates that left-sided values are unlike to those measured on right side, difference was greater in 2006 than in 2003. Habets, Kjellberg and AAI indexes are incomparable, however but each of them may be used as sufficient diagnostic tool.

Discussion

Habets was first to propose an index for assessment of asymmetry. This index was described by Buman and Lotzmann [5]. A more recent method of symmetry estimation was proposed in 1994 by Kjellberg. System developed by Habets allows to diagnose mandibular asymmetry, but do not determine which part of mandibular ramus is responsible for it, what limits its usefulness. Kjellberg index estimates proportions between mandibular condyle and ramus [5,6]. Our own asymmetry index, called angular asymmetry index (AAI), was developed for comparison

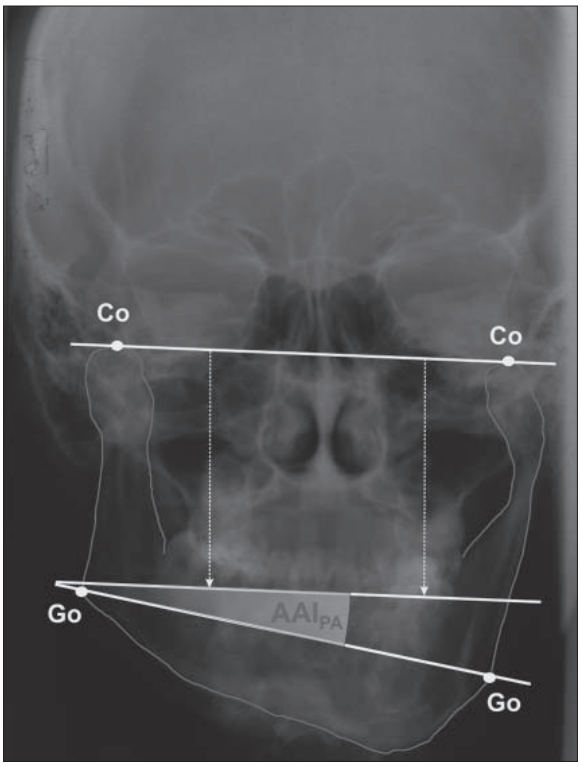

Figure 3. The radiographs view in PA projection. The calculation of AAI_{PA}.

of magnitude of asymmetry and its potential progression. Indices enable to recognize many structural bone disorders, including entities of unknown etiology [1–4,7,8]. Bone diseases affecting facial skeleton involving maxilla and/or mandible, such as fibrous dysplasia, cherubism, osteogenic fibroma and others not fully recognized are one of the reasons of malocclusion [1–4]. At the early stages, patients who look for medical advice are referred to orthodontic departments. Orthodontic treatment requires radiological investigations including panoramic views, like in reported case. Different etiology of asymmetric jaw deformities gives a lot of difficulties in diagnostic process. It is a problem to determine whether asymmetry is caused by mandibular growth center anomaly or by bone disease. Diagnostic difficulties are also associated with amount of asymmetry, its objective estimation during patients growth and its type, keeping

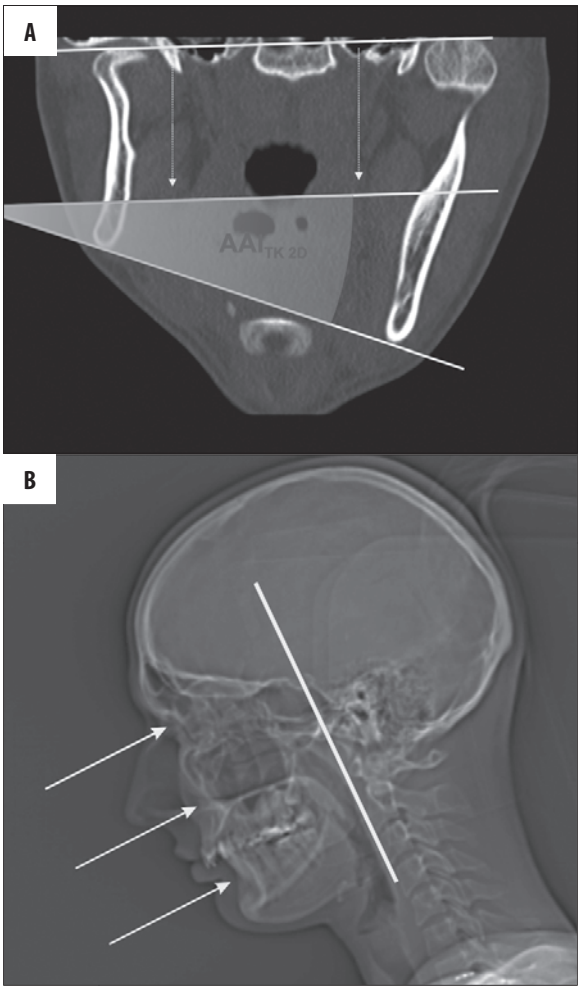

Figure 4AB. The radiographic view in PA projection. The calculation of AAI_{PA}.

on mind negative results of supplementary examinations. Intraoperative bone tissue biopsy makes histopathological diagnosis possible, like in a previously described case [9]. Presented patient, despite multidirectional investigations including skeleton scintigraphy, biochemical blood tests – level of alkaline phosphatase and hydroxyproline level in urine or histopathology, no ultimate diagnosis was established, which results great caution in decision making concerning the therapy [2–4]. However, according to Stafne [4] and Cawson [3] diagnosis of fibrous dysplasia could be suggested on the basis of radiograms only. Because of uncertain diagnosis authors consider further observation of clinical condition and asymmetry index values based on comparison of radiograms. Radiological findings and asymmetry indices are useful for follow up observation of unclear etiology lesions, especially at early low-symptomatic stages.

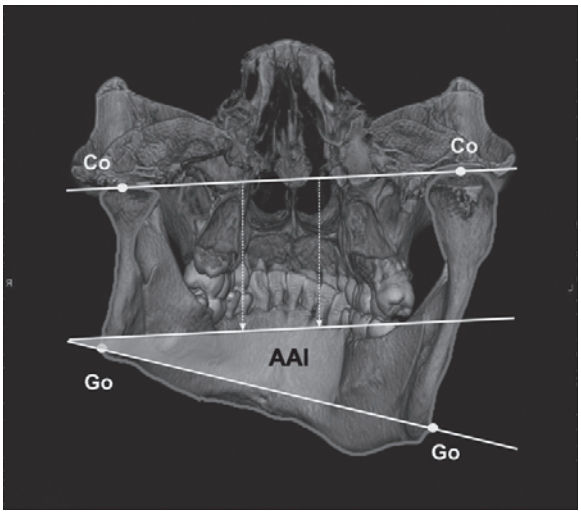

Figure 5. Scan of 3D reconstruction in PA projection of patient KK, view at back. The calculation of $AAI_{TK\ 3D}$.

Conclusions

1. Asymmetry indices are objective tool for mandibular growth estimation according to radiographic images; allow to determine which part of mandible is responsible for asymmetry.

2. AAI makes it possible to assess the progression rate of asymmetry.

3. All 3 indices: Habets, Kjellberg and AAI are incomparable however each of them can be used separately.

4. None of indices should influence comprehensive observation of clinical lesions that may occur in difficult, undiagnosed cases.

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