RESEARCH ARTICLE

The differences in parallelism between ala-tragus line and occlusal plane of down syndrome and normal individuals

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Submitted: 8th January 2019; Revised: 14th May 2019; Accepted: 25th June 2019

ABSTRACT

People with down syndrome have a different craniofacial structure compared to normal individuals. Commonly, down syndrome patients have abnormal ear morphology with smaller size, and lower ear position compared to that of normal subjects. These patients also have smaller nose, shorter maxilla structure and facial height. Other disorders are anomalies in tooth shape, numbers and size. The ala-tragus line is one of the anatomical landmarks to determine the occlusal plane orientation. Abnormalities in the anatomical structure of people with down syndrome can affect the parallelism between the ala-tragus line and the occlusal plane. The purpose of this research was to determine the differences in parallelism between the ala-tragus line and the occlusal plane of people with down syndrome and normal individuals. The sample in this study were people with down syndrome and normal individuals. The sample was photographed using a digital camera with a fox plane attached to the oral cavity. Parallelism of the ala-tragus line and the occlusal plane was analyzed by tracing these photographs. Photo tracing was done using the Autocad 2013 software. The mean value of angle on people with down syndrome (5.852° ± 5.367°) was greater than that of normal individuals (2.169° ± 2.557°).

Based on the research, it was concluded that the parallelism of the ala-tragus line to the occlusal plane in people with down syndrome was different from that in normal individuals. The ala-tragus inferior line in normal individuals was more parallel to the occlusal plane compared to that in people with down syndrome.

Keywords: ala-tragus line; down syndrome; occlusal plane; parallelism

INTRODUCTION

Down syndrome is a chromosomal abnormality due to an excessive number of chromosome 21. Individuals with down syndrome have three copies of chromosome 21 (trisomy) for a total number of 47 chromosomes per cell instead of the normal two copies. Human cells normally have 23 pairs of cell chromosomes.1-2 Thus, people with down syndrome generally have distinctive physical characteristics, including abnormalities in the head and facial structure with smaller skulls, anteroposterior flattened skull, slanted eyes, flat bridge-nose, smaller ears, and muscle hypotonia.1,3 The nasal bone, midfacial bone, and maxilla are relatively smaller in size, which is caused by the occurrence of midfacial hypoplasia. Teeth abnormalities, such as tooth agenesis, microdontia, malformations of teeth, smaller clinical crown than the normal tooth, smaller and conical tooth root, also occur in people with Down syndrome.4

People with down syndrome have problems in physical and intellectual abilities so that their abilities in learning and communication are limited.4,5 These limitations affect their ability to maintain the oral health, so that people with down syndrome, especially the adults, have a high prevalence of periodontal disease and have an increased risk of dental caries.7 The research of Shukla et al.5 showed that the prevalence of caries occurred in 78% of down syndrome subjects, 33.8% of subjects experienced tooth loss, and 90% of subjects with down syndrome needed periodontal treatment. The
high prevalence of periodontal and caries diseases in people with down syndrome increases the risk of losing teeth, so that denture treatment is needed. Determination of the occlusal plane orientation is one of the important steps in complete dentures fabrication or fabrication of partial dentures with extensive tooth loss in the maxilla. The occlusal plane has an important role in aesthetic function, phonetics, mechanical concepts of balanced occlusion, and denture stability. Therefore, a reference plane is needed to determine the area of occlusal plane orientation. The reference plane that is often used is the ala-tragus line or Camper’s line. The ala-tragus line is a line drawn from the inferior border of the ala of the nose to a certain point in the tragus of the ear. Determination of the exact point in the ear tragus is still controversial. Previous researchers divided the ear tragus into 3 different points, namely the superior tragus, middle tragus, and inferior tragus. Nayar et al. and Kumar et al. reported that the occlusal plane in a normal individual is almost parallel to the line drawn from the ala of the nose to the inferior border of the tragus.

Research on the occlusal plane of people with Down syndrome has never been studied in the literature. Specific abnormalities in the structure of the head, face, ears, oral cavity, and teeth on down syndrome subjects can affect the parallelism between the occlusal plane and the ala-tragus line. On this basis, this study aims to answer the following research questions: are there any differences in parallelism between ala-tragus line and the occlusal plane of individuals with down syndrome and that in normal individuals? This research aimed to determine the differences in parallelism between the ala-tragus line and the occlusal plane of people with down syndrome and that in normal individuals.

MATERIALS AND METHODS

The research conducted was a cross sectional study. It was conducted at the Rumah Sakit Gigi dan Mulut (RSGM) Faculty of Dentistry, Universitas Padjadjaran in June-August 2016 and in SLB in July-August 2016. This study was approved by the Research Ethics Committee, Faculty of Medicine UNPAD (Ethics Approval Letter No. 440 / UN6. C1.3.2 / KEPK / PN / 2016). The population in this study were people with down syndrome from POTADS (Parent Association with down syndrome Children) Bandung, SLB C YTB and SLB ABCDE-LOB Bandung. Normal individuals in this study were the students from Faculty of Dentistry UNPAD. The research sampling from the population was done by purposive sampling. The inclusion criteria for the study sample included a minimum age of 18 years for women and a minimum age of 20 years for men; People with down syndrome having at least one tooth in the anterior and two teeth posteriorly, while normal individuals should have the permanent teeth that have all erupted for 28-32 pieces; There was no persistence of deciduous teeth which can interfere with the determination of the occlusal plane; There were no extruded teeth; The incisal of the anterior teeth and the cusp of posterior teeth must be intact, with no attrition, fracture or filled; and the research samples were cooperative and willing to be the subject of research. The exclusion criteria for the sample were: Using denture either fixed or removable; having done orthodontic treatment; and having malocclusion or severe crowding which would complicate the determination of the occlusal plane.

The tools used in this study were Fox plane/ Fox bite plane (Asko, Indonesia), digital camera (Canon Digital Ixus 175; 2 0.0 MP, Japan), and tripod (Motto Excel 2830). The subjects who met the inclusion criteria were selected as the sample in this study. Subjects in normal individuals were asked to sign informed consent while subjects with down syndrome had their informed consent signed by parents/guardians. The subjects were instructed to sit on the examination chair with their back and head upright. Fox plane was positioned in the occlusal of the maxilla until the fox plane was stable in the mouth, and incisal and occlusal surfaces of the teeth touched the Fox plane. Fox plane was held in position by the operator, and the subject was photographed from the right or left side. The camera was mounted on a tripod, and the camera...
height was adjusted to the position of the subject’s head until the fox plane was seen as a straight line on photo. The distance between the camera and the subject’s sagittal plane was one meter. The parallelism of the fox plane with the ala-tragus line was then analyzed in the photo results.\textsuperscript{9,12} Tracing the photo was done using Autocad 2013 software (Autodesk, USA).\textsuperscript{9,12} The line was drawn from the inferior border of the ala of the nose to the tragus point (superior, middle and inferior) then the angle of intersection between the fox plane with each ala-tragus line was measured (Figure 1). The resulted angle values were recorded for data analysis.\textsuperscript{9,12} The ala-tragus line which is considered as the most parallel to the occlusal plane is the line that forms the smallest angle to the fox plane. Data analysis of this research was carried out using t-test to test the difference of two mean values in two populations.

![Figure 1](image)

**Figure 1.** (A) Profile picture of the subject with a mounted Fox plane, the Fox plane appears as a straight line; (B) Photograph of the subject after tracing using Autocad 2013

**RESULTS**

The population of people with down syndrome amounted to 197, and of this number, 12 people met the inclusion criteria. The number, age and sex of the normal individuals samples were adjusted to those of down syndrome samples (Tables 1 and 2). The intra-oral conditions of people with Down syndrome are described in Table 3.

| Table 1. Number and sex of samples of with Down syndrome and those of normal individuals |
| --- |
| Gender | Individuals with Down syndrome | Normal Individuals |
| | F | % | F | % |
| Women | 5 | 41.67 | 6 | 50.00 |
| Men | 7 | 58.33 | 6 | 50.00 |
| Total | 12 | 100 | 12 | 100 |

| Table 2. Age of samples |
| --- |
| Age (years) | Individuals with Down syndrome | Normal Individuals |
| | F | % | F | % |
| 18-23 | 5 | 41.67 | 2 | 16.67 |
| 24-29 | 5 | 41.67 | 9 | 75.00 |
| 30-35 | 2 | 16.66 | 1 | 8.33 |
| Total | 12 | 100 | 12 | 100 |

| Table 3. Intra-oral and ear conditions of persons with Down syndrome |
| --- |
| Condition | F | % |
| Caries | 4 | 33.33 |
| Agenesis | 4 | 33.33 |
| Crowding | 5 | 41.67 |
| Bad oral hygiene | 4 | 33.33 |
| Tooth shape anomalies | 1 | 8.33 |
| Low set ear | 7 | 58.33 |

The angle value between the occlusal plane (OP) with the superior ala-tragus line (AT1), middle ala-tragus (AT2), and inferior ala-tragus (AT3) is not exactly 0°, both in normal individuals and in persons with down syndrome. Parallelism of ala-tragus line with the occlusal plane was seen from the angle value formed by the intersection of the ala-tragus line with the occlusal plane (ATx-OP). The smallest angle value was considered as the ala-tragus line which was the most parallel to the occlusal plane (Table 4). Table 5 and Figure 2 shows the mean value of the smallest angle between ala-tragus line with the occlusal plane (Angle ATx-OP) in people with down syndrome and that in normal individuals.

| Table 4. Smallest ATx-OP Angle Value Distribution |
| --- |
| The smallest ATx-OP angle | Individuals with Down syndrome | Normal Individuals |
| | F | % | F | % |
| T1 | 1 | 8.33 | 2 | 16.67 |
| T2 | 0 | 0.00 | 2 | 16.67 |
| T3 | 11 | 91.67 | 8 | 66.67 |
| Total | 12 | 100 | 12 | 100 |
Table 5. Mean values of the smallest angle between the ala-tragus lines with the Occlusal Plane (Atx-OP Angle) in people with down syndrome and that in normal individuals

|                      | Individuals with down syndrome (degrees) | Normal individuals (degrees) |
|----------------------|------------------------------------------|------------------------------|
| Mean                 | 5.852                                    | 2.169                        |
| SD                   | 5.367                                    | 2.557                        |
| N                    | 12                                       | 12                           |

The analysis of student t-test in this study obtained the value $t = 2.15$ with p-value $= 0.043$ (p-value $<0.05$). This shows that there are significant differences in the mean angle values of persons with down syndrome and that in normal individuals.

DISCUSSION

The number of samples of people with down syndrome was not as previously expected since there were difficulties in finding people with down syndrome who were aged 18 years and above. Those aged 18 and above have passed the school age limit, so that only a small number of students in SLB met these age criteria. Besides, most of those with down syndrome who are members of POTADS Bandung were less than 14 years old. The presence of people with down syndrome who meet the inclusion criteria but are not cooperative also led to a limited number of samples obtained.

The criteria for sample age was 18 years and above for women and 20 years and above for men. The age of the research subjects was distinguished between men and women because it was expected that the growth of the maxillary, mandibular, facial, and surrounding structures of the research subjects had stopped. The cessation of facial growth in men and women is different. Based on the literature, facial growth stops at the age of 15 years for women, while that in men stops at the age 17-18 years. Complete maxillary and mandibular growth stops at the age above 17 years in women and 20 years of age for men. Therefore, the sample age of men and women was made different so that the anatomical points used as a reference in this study are relatively constant benchmark points.

The angular values between the occlusal plane and the ala-tragus line (AT1-OP; AT2-OP; and AT3-OP) are not exactly $0^\circ$, both in normal individuals and in people with down syndrome. The results of this study are in accordance with the results of Nayar et al., Kumar et al., Chaturvedi et al., and Dean et al. in that there is no angle value right at $0^\circ$. The results of this study show that the ala-tragus line, which is the most parallel to the occlusal plane in a normal individual, is the inferior Al-tragus line (AT3). This is consistent with the finding of the previous researches stating that the line from the lower border of the ala nose to the inferior tragus is the most parallel ala-tragus line to the occlusal plane and can be used as a guide to determine the parallelism of the occlusal orientation plane in dentures fabrication.

The results of the Venugopalan et al., showed that the occlusal plane in normal individuals with class I and III malocclusions is parallel with the line from the lower border of ala nose to the inferior border of tragus, while the occlusal plane in normal individuals with class II malocclusion is parallel with the line from the lower border of ala nose to the middle border of the tragus. Occlusion classifications in this research were not considered in the research criteria. This was due to the limited number of down syndrome samples. The study by Shaikh et al. showed that normal individuals in the young adult age group (20-35 years) have an occlusal plane that is more parallel to the inferior ala-tragus line, whereas the occlusal plane of the older adult group (36-50 years) is parallel to the middle tragus line. The group of down syndrome...
samples and normal individuals in this study belonged only to one age group, that was young adults (18-35 years). The study by Bondekar et al.\textsuperscript{17} showed that the middle ala-tragus line is parallel to the occlusal plane. Sadr and Sadr\textsuperscript{18} stated that in normal individuals there was no parallel between the occlusal plane and the ala-tragus line in the three tragus points (superior, middle, inferior) because no angle with zero degrees was obtained. The superior ala-tragus line has the smallest angle value and is considered to be the most parallel to the occlusal plane.\textsuperscript{18}

The results of this study show that the mean angle of the ala-tragus line in normal individuals is $2.169^\circ \pm 2.557^\circ$ located on the inferior ala-tragus line. The mean value of the study in Nayar et al,\textsuperscript{9} is $3.914^\circ$, and Dean et al.,\textsuperscript{16} is $2.94^\circ$ located on the inferior ala-tragus line. The mean value of the study in Sadr and Sadr\textsuperscript{18} is $1.80^\circ \pm 3.12^\circ$ located on the superior ala-tragus line. The Abi-Gohsn et al.\textsuperscript{19} showed the Ala-tragus line which is the most parallel to the occlusal plane is the middle ala-tragus line with an angle mean value of $3.275^\circ \pm 2.54^\circ$. In this research, the standard deviation value of normal individual is greater than the mean value of the angle of the ala-tragus line ($2.169^\circ \pm 2.557^\circ$). This is attributed to the small number of sample size and the wide range of angle values in normal individual. The number of samples of normal individuals is adjusted by the number of samples of persons with down syndrome. The standard deviation value that is greater than the mean value is also seen in the results of Sadr and Sadr’s research\textsuperscript{19} ($1.80^\circ \pm 3.12^\circ$).

There was no research to address parallelism of the ala-tragus line with the occlusal plane in persons with down syndrome in the literature, so it was difficult for the researchers to find references. The result in this study shows that the inferior ala-tragus line (AT3) is the most parallel line to the occlusal plane in persons with down syndrome and the normal individual but the mean value of angle in down syndrome ($5.852^\circ \pm 5.367^\circ$) in this study was greater than that of normal individuals ($2.169^\circ \pm 2.557^\circ$). The mean value of persons with down syndrome in this study is greater than the results of previous studies in normal individuals.\textsuperscript{9,16,18,19} The difference in the mean angle value occurs because of an ear abnormality (low set ear), which causes the ears of people with down syndrome to be rotated and lower than those of normal individuals.\textsuperscript{20} Low set ear is found in 58.33% of the sample. This result is similar to the study of Azman et al.\textsuperscript{21} that is, the low set ear was found in 56.1% of the sample. Low set ear is also found in most of the samples in the study of Podder et al.,\textsuperscript{12} that is as much as 71.8%, while the study of Bartelli\textsuperscript{23} revealed that low set ear is only found in 16.1% of samples of down syndrome children. The lower ear portion and rotation cause changes in the tragus position that affects the parallelism of the ala-tragus line with the occlusal plane.

Intra-oral examination showed that a small proportion of people with down syndrome in this study had dental agenesis (33.33%) and anomalies in dental morphology (8.33%). This result is similar to the study of Shukla et al.\textsuperscript{5} with 33.8% samples having dental agenesis and 45.5% have microdontia abnormalities. The presence of agenesis and tooth shape anomalies in some persons with down syndrome can affect the position of the fox plane in the oral cavity, thereby changing the parallelism of the ala-tragus line with the occlusal plane.

The mean angle formed by the ala-tragus line with the occlusal plane of down syndrome is greater than that of normal individuals. This means that the ala-tragus line in people with down syndrome deviates further than zero degrees compared to that in normal individuals. The ala-tragus line in persons with down syndrome is less parallel to the occlusal plane compared to normal individuals.

The inferior border of the ala nose and ear tragus is an extra oral landmark that can be used as a reference plane to determine the occlusal plane because both are relatively constant and not affected by the aging process. The majority of the previous study showed that the occlusal plane was parallel to the inferior ala-tragus line\textsuperscript{9-12,15,16} but some other studies demonstrated that the occlusal plane is parallel to the superior ala-tragus line\textsuperscript{18} and middle.\textsuperscript{11,12,17,19,24} The occlusal plane parallelism should be determined not only...
from one anatomical landmark but also from a combination of other anatomical landmarks. The other anatomical landmark that can be used as a guide for determining the occlusal maxillary plane is the hamular notch- papillary incisor.

Jain and Shigli stated that more than one anatomic landmark is needed to determine the occlusal plane accompanied by clinical assessment to obtain the ideal occlusal plane. Nayar et al., stated that the determination of the occlusal plane, besides using reference anatomic landmarks also required clinical assessment that prioritized aesthetic satisfaction, function, and stability of dentures. Further research is needed regarding the parallelism of ala tragus line with the occlusal plane, with a larger number of samples to find alternative anatomical landmarks that can be used as reference plane to determine occlusal plane parallelism in normal individuals and that in persons with down syndrome.

CONCLUSION

Based on the research, it can be concluded that the parallelism between the ala-tragus line and the occlusal plane in people with down syndrome is different from that in normal individuals. The inferior Al-tragus line in normal individuals is more parallel to the occlusal plane as compared to that of people with down syndrome.

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