

Reliability of Ashley Howe's analysis in South Indian population

Aravinthraj Kumar Govindaraj*, S. Aravind Kumar, M. Srengalakshmi

ABSTRACT

Introduction: The study models were the first diagnostic records used in orthodontic diagnosis and treatment planning. Many authors have introduced different analysis to assess the relationship between the teeth and respective arch dimensions. Ethnic variations in the genesis of malocclusions have been studied; hence, any index developed for a particular group of population cannot be applied as such to another group. The main aim of this study is to evaluate the reliability of Ashley Howe's analysis on South Indian population. **Materials and Methods:** Diagnostics models of 30 dental students and patients with Angle's Class 1 malocclusion with crowding or spacing <math><2-3\text{ mm}</math> were used for the analysis. The impressions are made using alginate and the casts are poured using orthocal stone (type 5 gypsum). All the values required for the analysis including the premolar width (premolar diameter), premolar basal arch width (PMBAW), and the total tooth material (TTM) are measured using a QST is the Company name and it doesn't have full form metal express digital Vernier caliper and the PMBAW percentage (PMBAW%) is calculated by the formula given in the original study by Ashley Howe. The values obtained are tabulated in Excel sheets. **Results:** The results showed that there is a significant difference between the values obtained from the original study of Ashley Howe and the current study in South Indian population. The mean of the TTM and the PMBAW% values obtained from the current study is significantly different from the original study. **Conclusion:** Ashley Howe's analysis is not reliable in South Indian population. Ethnic variations are seen between the original study which is done on a mixed population and the current study which is done on the South Indian population.

KEY WORDS: Ashley Howe, Diagnosis, Malocclusion, Model analysis, Orthodontics

INTRODUCTION

Due to increase in demand for an esthetic and appealing facile features and smile, the number of patients undergoing orthodontic treatment, nowadays, has increased considerably in the past few decades. Diagnosis and treatment planning are one of the key steps to any orthodontic treatment. Taking proper case history and diagnostic records are very essential to arrive at a proper diagnosis and formulate the treatment plan for the particular patient. Diagnostic aids used in orthodontic treatment planning were broadly divided into essential or non-essential diagnostic aids. Essential diagnostic aids are the aids which are mandatory for all the patients undergoing orthodontic treatment. It includes the case history, diagnostic models,

radiographs, cephalograms, orthopantamograms, and the photographs. Photographs may be further divided into intraoral photographs (which include the photographs of the dentition, the individual arches, and the arches in occlusion) and the extraoral photographs (which include photographs of the face in frontal smile and at rest, 45° smile and at rest, and the profile photographs). Composite photographs are also taken in some cases; it provides information regarding any asymmetry of the face if present. Non-essential records are the records which are not essential for all the cases and are necessary for the particular patient. It includes any specialized radiographs such as the hand wrist radiograph to find out the growth status, computed tomography (CT), magnetic resonance imaging, basal metabolic rate, or any vitality test or biopsy.

Diagnostic models are the first essential diagnostic records that are obtained by pouring the impressions made during the patient's first visit to the dentist for

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Department of Orthodontics, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India

*Corresponding author: Dr. G. Aravinthraj Kumar, Department of Orthodontics, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India. Phone: +918072332799. E-mail: draravinthraj.kumar.sav@gmail.com

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orthodontic treatment. Diagnostic models can be used to study the various relationships of the tooth material or tooth size and position with its supporting alveolar bone or tooth base. They are also used to find out the relationships between the upper and the lower arches and to see if there any discrepancies. Various authors have introduced analysis to study these relationships and have arrived at formulas and average values for the same.

Ashley Howe's analysis gave information regarding the relationship of the tooth position with its apical base. According to Ashley Howe, the apical base is that part of the body of the maxilla from which the maxillary alveolar process has developed. He stated that, if we cut through the maxilla horizontally at the level of the apices of the teeth, we would cut off the alveolar process and expose this supporting base. He concentrated more on the maxillary apical base than the mandible as according to him, it was the greater factor for the production of malocclusion.

Various authors compared the reliability and validity of these analyses for the Indian populations and discussed about the variations and genetic emphasis of the etiology of malocclusion. They also have showed that Howe derived his index values from a limited number of sample ($n = 14$). However, he did not derive standard deviation (SD) for his sample except for the mean values and range. Therefore, only an appropriate comparison should be made for the use of these analyses as a method for arriving at a diagnosis and a proper treatment plan for the malocclusion.

MATERIALS AND METHODS

Diagnostic models of various dental students and patients who fell into the inclusion criteria were obtained from the impressions made in the Department of Orthodontics and Dentofacial Orthopedics in Saveetha Dental College and Hospital, Chennai, were used for the analysis. Impressions were made for all the subjects using tropicalgin alginate and the impressions were poured using Orthokal type 5 gypsum product. A QST express metal digital Vernier caliper was used for measuring the values for the analysis. 30 diagnostic models of the patients of belonging to the South Indian population were obtained from these impressions.

Inclusion Criteria

The following criteria were included in the study:

1. Patients between the age of 18–30 years with full complement of teeth
2. Patients with mild dental malocclusions (Class 1 malocclusions with mild crowding or spacing <2–3 mm)
3. Patients with acceptable facial profile.

Exclusion Criteria

The following criteria were excluded from the study:

1. Patients with severe malocclusions
2. Patients with poor oral hygiene
3. Patients with teeth with severe carious lesions or periodontal problems
4. Patients with a previous history of undergoing orthodontic treatment.

Armamentarium used:

1. QST express metal digital Vernier caliper
2. Sharp tip lead pencil for marking.

According to Ashley Howe, tooth crowding is due to the deficiency in the arch width than the arch length. The values those are required for doing the analysis include the premolar diameter (PMD), which is the distance between the buccal cusp tips of two first maxillary premolars which signify the arch width. The premolar basal arch width (PMBAW) is the distance between the right and left canine fossae and it gives the arch width in the region of the apical base. PMBAW percentage (PMBAW%) is obtained from the formula derived by Howe that is by dividing the PMBAW by total tooth material (TTM) and multiplying it with 100. The TTM is obtained by calculating the sum of maximum mesiodistal width of all the teeth from permanent first molar on one side to the other.

All the values were measured by a single person using the digital Vernier caliper to prevent any bias during the measurement and the calculations were made using the above-mentioned formula. The inference was obtained as follows: If the PMD is less than the PMBAW, then it indicated that the arch expansion is possible and if the PMD is less than the PMBAW, it indicated that expansion is not possible.

Ashley Howe also stated that to achieve a normal occlusion with a full complement of teeth, the PMBAW should be 44% to the TTM which is obtained by calculating the mesiodistal width of all tooth anterior to the maxillary second permanent molar.

All the values obtained by measuring the dental diagnostic models are tabulated and the result was obtained [Table 1].

RESULTS

The values of the original Ashley Howe's study which was published in the year 1947 and the values of the current study are given in the Table 1 and Table 2 respectively.

Ashley Howe's Study

The values used by Ashley Howe in his original article^[1] are tabulated in the following tabular column. This study was done on a mixed population. Moreover,

Table 1: Values Obtained from Ashley Howe's Analysis

Ashley Howe's study	PMD	TTM	PMBAW	PMBAW%
Gloria	46.2	91.2	39	43
Norma A	46.4	93.2	42	45
Arthur B	47.6	97	43	44
Lucille	43.6	87.2	38.7	43.5
Evelyn K	48.4	93.9	41	43.5
Paul S	50.2	99.6	52.5	42.5
Ethel P	46.8	92.3	39.2	42.5
Italian	49.4	96.8	44.6	46
Aged	46.6	92.5	39.5	42.7
Mrs B	48.4	93	40.6	43.6
Evelyn U	49.8	97	42.3	43.6
Negro	48.4	96.2	43.8	45.5
Katie	46.8	91.4	41.1	44.8
Stanley	48.8	93.5	41	43.9
Mean	47.6714	93.9142	42.02143	43.86429
SD S	1.74991	3.16005	3.509148	1.097274

TTM: Total tooth material, PMBAW%: Premolar basal arch width percentage, SD: Standard deviation, PMD: Premolar diameter

the values of the TTM, PMBAW, and PMBAW% are mentioned in their respective columns and the mean and SD are also obtained for the same.

Current Study

The values obtained from the diagnostic models were tabulated using Microsoft Excel application and are given in the following table. The PMBAW% is calculated by the formula given by Ashley Howe in his original article and is also mentioned in the table. The names of the subjects took part in the study are mentioned in the first column followed by the maximum mesiodistal width of all the permanent tooth in upper arch mesial to the permanent second molars is mentioned. Then, it is followed by the TTM, PMBAW, and the PMBAW% values. The values are used to find the mean and SD of the 30 subjects ($n = 30$) who took part in this study.

DISCUSSION

Comparing the values obtained from the original Ashley Howe's study with the current study, the results from the current study showed that there are definite variations in the mean and standard deviation values of the TTM, PMBAW, and PMBAW%. It showed that the mean PMBAW% to the TTM was around 45.848 with a standard deviation of 2.238. Although the sample size taken in the current study is more than the original Ashley Howe study, further increase in the sample size is very essential to prove the statistical significance of the same.

Previous studies regarding the prevalence of malocclusion and reliability of various model analyses are discussed below. Due to the increased demand for the esthetic and appealing facial features, the number of patients undergoing orthodontic treatment has increased considerably in the past few decades. Having an esthetic smile is essential for social and the

psychological development of the patient.^[2] Dibiasi and Sandler^[3] stated that there is minimal evidence of a marked increase in the self-esteem of the subject following orthodontic treatment in children. The long-term psychological improvements of orthodontic treatment are very difficult to measure, but there is an increasing awareness of malocclusion with age. Sandeep and Sonia^[4] studied the pattern of dental malocclusion in Rwanda and stated that Angle's Class 1 malocclusion is seen in almost 60.9% of the subjects who took part in the study. They also stated that there was an increased prevalence of crowding in lower anterior teeth in the subjects included in the study.

The prevalence of malocclusion has been increased in the past few decades. Various studies showed the increased prevalence of malocclusion. Prabhakar *et al.*^[5] stated that the prevalence of malocclusion helped the orthodontist to frame up his treatment modalities be it interceptive or preventive orthodontics. Thilander *et al.*^[6] studied the prevalence of malocclusion in the children and adolescents of Colombia stated that 88% of the children had some form of occlusal anomalies. The study showed that there was an increased prevalence of Angle's Class 1 malocclusion in the sample population taken into the study. In a study done in Maharashtra by Vibhute *et al.*,^[7] it has been stated that esthetics were the ruling chief complaint for the patients seeking orthodontic treatment. To obtain an esthetic facial profile and appealing smile have become one of the major demands of the patients undergoing orthodontic treatment. There are only few patients who undergo orthodontic treatment for functional demands. They also studied the need for orthodontic treatment and stated that 30.71% of the subjects included in the study were in great need for orthodontic treatment. Although there was increased prevalence of patients undergoing orthodontic treatment, there are studies^[8] which prove the release of nickel ion release, the quantity of nickel

Table 2: Values Obtained from the Current Study

Subject name	16	15	14	13	12	11	21	22	23	24	25	26	TTM	PMBAW	PMBAW%	PMD
Yuvraj	10.05	6.53	7.92	9.37	7.61	9.27	9.34	7.92	8.53	7.36	6.51	10.34	100.75	43.59	43.2655	44.16
Ayan Raj	10.17	6.78	7.04	8.54	9.06	8.44	8.51	8.36	7.57	7.33	6.44	10.03	98.27	43.35	44.1131	43.79
Aravind	10.01	6.93	7.78	7.91	7.05	8.37	8.29	7.53	8.1	7.1	6.77	10.16	96	42.32	44.0833	44.19
Akila	9.52	6.45	6.99	7.68	7.17	7.25	8.1	6.99	7.6	6.53	6.13	9.67	90.08	41.72	46.3143	42.74
Madhumathi	9.75	6.27	6.97	7.11	6.12	8.04	7.91	6.36	6.72	6.67	6.45	9.74	88.11	39.79	45.1594	41.6
Rajesh Kumar	10.68	7.45	6.94	7.9	7.27	8.38	8.29	6.55	7.28	6.95	6.73	1.2	94.62	44.43	46.9562	45.15
Balaji	10.36	6.41	7.08	7.36	6.48	7.93	8.13	6.85	6.95	6.59	6.4	10.26	90.8	41.88	46.1233	42.46
Balamurugan	9.85	6.47	7.1	7.67	7.53	8.49	8.16	6.45	7.68	6.91	6.59	9.82	92.65	41.38	44.6627	44.37
Aysha	9.64	6.02	7.78	7.91	6	7.45	7.59	5.35	6.69	6.24	6.91	9.46	88.39	34.87	39.459	43.11
Revathy	10.18	6.26	6.91	7.16	5.96	8.3	8.05	5.5	7.42	7.27	6.24	9.78	88.98	42.13	47.3477	42.83
Sri Lakshmi	9.34	6.85	7.05	7.72	7.3	7.63	7.75	6.67	7.32	6.77	7.27	9.43	91.38	42.65	46.6732	42.28
Vijayalakshmi	10.45	6.29	6.44	7.34	6.18	8.49	8.28	6.34	7.33	6.6	6.77	10.23	90.92	41.26	45.3805	42.62
Arul	9.42	6.19	6.77	7.1	6.15	7.12	6.94	6.04	7.02	5.98	6.6	9.37	85.2	41.11	48.2511	39.88
Priyadarshni	9.92	5.75	6.6	7	6.21	7.88	7.87	6.13	6.94	6.04	5.98	9.51	86.11	36.59	42.4921	39.92
Sankavi	9.88	5.64	6.57	7.21	5.53	7.78	7.98	5.63	7.04	5.45	6.04	9.68	85.57	39.24	45.8571	39.96
Jagadeesh	9.34	6.25	6.55	7.45	7.05	8.14	8.24	6.96	8.19	7.26	5.45	9.08	89.8	44.12	49.1314	43.04
Elakkiya	10.13	6.44	6.83	7.32	5.51	8.77	8.9	6.11	7.61	5.62	7.26	9.76	91.18	40.32	44.2202	40.19
Meena Pria	8.78	6.58	6.66	6.74	6.52	7.75	8.16	6.38	6.64	6.86	5.62	8.85	58.38	40.65	47.6106	41.11
Roopika	10.17	5.86	6.22	7.56	6.26	8.36	8.66	6.35	7.69	6.62	6.86	9.83	90.25	40.34	44.698	41.28
Mugilan	9.84	6.48	7.13	7.76	7.13	8.52	8.42	7.32	7.85	6.32	6.62	10.05	94.36	42.69	45.2416	43.3
Balaji	9.06	6.41	6.61	8.08	6.24	8.28	8.19	6.12	7.57	6.51	6.34	8.76	88.7	41.13	46.3697	39.12
Hari Priya	10.64	7.08	7.27	7.95	7.38	9	8.86	7.31	7.78	6.41	6.51	9.86	96.35	40.59	42.1276	39.26
Keshaav Krishna	9.71	6.25	7.13	8.21	6.36	8.1	8.2	5.82	8.22	6.78	6.41	9.61	91.39	43.55	47.6529	43.8
Nanda Kumar	9.81	6.71	7.14	8.43	6.95	8.21	8.76	7.05	8.27	6.44	6.78	10.08	94.75	45.24	47.7467	45.32
Jaekson	8.92	6.45	7.37	8.02	7.64	9.33	9.16	7.22	7.72	6.38	6.44	9.25	94.71	44.24	46.711	45.01
Surender Babu	10.01	6.06	6.97	7.48	6.29	9.08	8.83	6.21	6.55	6.08	6.38	10.19	91.65	40.89	44.6153	40.17
Sinduja	9.21	5.93	6.77	7.32	5.87	7.91	7.82	6.19	7	6.55	6.08	9.17	85.82	40.36	47.1936	41.68
Saravanan	9.62	6.6	7.43	8.19	6.96	8.77	8.48	6.93	7.97	7.34	6.55	9.39	94.23	46.52	49.3685	45.51
Sabiya	9.56	5.84	5.93	7.37	6.52	8.07	8.08	6.86	6.66	6.96	6.06	9.81	87.72	39.78	48.6784	38.96
Mariya	9.33	5.76	5.84	7.47	6.27	7.91	8.03	6.18	7.31	6.51	6.26	8.91	85.78	41.14	47.9598	42.2
Total													90.996	41.59567	1375.464	42.30033
Mean													3.994413	2.333596	2.201077	1.943539
SD P													4.062699	2.37349	2.238705	1.973568
SD S																

TTM: Total tooth material, PMBAW%: Premolar basal arch width percentage, PMD: Premolar diameter, SD: Standard deviation

ion released was not a big concern for the use of the fixed orthodontic appliance.

Ashley Howe in his original study described the relationship between the tooth structures to its arch base. The study by Felicita *et al.*^[9] which studied the craniofacial relation among the subethnic Indian population stated that the anterior maxilla, posterior maxilla, and cranial floor-ramus vertical composite are in a dimensional balance in the subjects with facial harmony and normal occlusion. Facial keys to orthodontic diagnosis and treatment planning were studied by Arnett and Bergman^[10] gave a comprehensive clinical facial analysis.

Although there were studies which studied the reliability of various model analyses in their population, the main concentration in the previous literature was about reliability and the reproducibility of digital model analysis and their comparison with conventional model analysis in formulating treatment plan for the patient. Reliability, validity, and reproducibility of plaster versus digital study models were studied by Stevens *et al.*^[11] showed that digital models were not a compromised mode for diagnosis or treatment planning. The use of cone-beam CT in orthodontic diagnosis was studied by Kau *et al.*^[12] and Baumgaertel *et al.*^[13] The comparison of the reliability and reproducibility between various three-dimensional model analyses with conventional model analysis was studied.^[14-17] They showed the increased accuracy of the computer-generated model analysis and stated that there was reduced interobserver reliability in conventional model analyses. A validation study of the dental models made with an intraoral scanner was studied by Cuperus *et al.*^[18] showed that the stereolithographic and digital models were valid and reproducible methods for measuring the distances on a dentition.

A systematic review was done to compare the orthodontic measurements on digital study models with plaster models by Fleming *et al.*^[19] showed that digital models were an alternative to conventional methods and may be recommended for the purpose of model analysis, but the evidence showed in that review was of variable quality. The validity and reproducibility of three different methods of measuring tooth widths were studied by Naidu *et al.*^[20] showed that both digital models and digital photographs showed very good validity and reliability, but the digital models were more accurate than the digital photographs. The reliability of various model analyses is also studied by Pawar *et al.*^[21] in the population of North Karnataka. They studied the reliability of all the available model analyses and stated that only the Bolton's index can be used as a useful clinical guide for the diagnosis and Pont's index was the least reliable. They also showed

that there was difference in the index values of Ashley Howe's analyses from their study to the original study. Heritability of malocclusion was studied by Mossey.^[22] stated that malocclusion being polygenic is also influenced by external environment. Genetic paradigm in orthodontics was studied by Singh *et al.*^[23] showed that malocclusion was the result of the combination of various genetic and environmental factors. The various evolving concepts of genetics and heredity in orthodontics were studied by Carlson^[24] stated that the fundamental concepts from genetics and applied research in orthodontics provided a new foundation for precision orthodontics and thus providing a significant advancement on future orthodontic treatment plan with the involvement of modern genomic basis.

CONCLUSION

Increased prevalence of malocclusion and increase in the esthetic demand among the population have increased the awareness and the number of people undergoing of orthodontic treatment in the past few decades. A well-framed case history with proper patient records, diagnostic models, radiographs, and analysis of the same is very essential to arrive at a proper diagnosis and treatment plan of any malocclusion. Genetic influence of malocclusion was emphasized and thus, an index which was formulated for a particular population cannot be used as a standard index for all the populations. We conclude this study by stating that Ashley Howe analysis is not reliable on South Indian population. However, further study with increase in sample size and gender variations will be essential to further obtain an accurate standard mean value for the same. Thus, it is very essential to formulate a model analysis with the average values from the samples obtained from the subjects of the particular population.

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