Comparison Between Manual and Digital (2D) Measurement of Peer Assessment Rating (PAR) Score Index (Component 1-6)

Tri Wahyudi[1], Miesje Karmiati Purwanegara[2], Nada Ismah[2]*

1. Orthodontics Residency Program Faculty of Dentistry, Universitas Indonesia, Jakarta.
2. Department of Orthodontics Faculty of Dentistry, Universitas Indonesia, Jakarta.

Abstract

Over the years, Peer Assessment Rating index measurement is usually recorded using manual assessment. Along with the technology improvements, PAR index software are being developed to help orthodontists in measuring the PAR index digitally. The aim of this study is to compare the result of PAR score index (component 1-6) between the manual and digital measurement. Sixty samples that match the inclusion criteria were scanned using HP Scanjet G4050 scanner device to obtain 2D digital study models. Manual measurements of the PAR score index (component 1-6) was assessed using PAR plastic ruler, while the 2D digital study models were measured using PAR index software. There were no significant differences between the measurement of PAR score index (component 1-6) in conventional and 2D digital study models (p>0,05). The measurements on 2D digital study models are as accurate as conventional study models.

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Introduction

Malocclusion is deviation / aberration / distortion of ideal occlusion esthetically or functionally.[1] Malocclusion also may be defined as deviation of normal occlusion. Malocclusion may be caused by genetic or environment factors.[1,2] Malocclusion may affect facial profile, the supporting tissues of the teeth and stomatognatic function. This situation may be corrected by orthodontic treatment.

Determining diagnosis in orthodontic treatment requires series of examination. Aside of clinical examination, radiographic examination (panoramic and cephalometric radiography) also study cast model are needed. Conventional study cast model is commonly used for study cast model analysis.[3] One of study cast model analysis method used is Peer Assessment Rating (PAR) index. PAR index is occlusal index made as instrument to measure how much teeth deviation from normal dental arch and occlusion.[4]

Corresponding author:
Miesje Karmiati Purwanegara,
Department of Orthodontics Faculty of Dentistry, Universitas Indonesia, Jakarta.
E-mail: miesjekar@gmail.com

PAR index measurement done using PAR plastic ruler, special ruler made by Richmond.[5] PAR index has all of the criteria needed as prerequisite of ideal occlusal index.[6-9] Nowadays, conventional study cast model is still be a gold standard in determining diagnosis and study cast model analysis measurement.[8-11] Conventional study cast model has some shortcomings, such as it is damaged, broken, and lost easily also it requires space storage. Some researchers and academics keep making efforts to overcome these shortcomings by creating various alternative form of conventional study cast model.[8,12]

Along with rapid development of digital technology, orthodontic diagnosis determination process may be done digitally.[12-14] Digital study cast model analysis measurement able to produce fast, accurate data and easily done compared with manual measurement of conventional study cast model.[8,15,16]

To overcome these problems, PAR index software is currently being developed which able to measure PAR index automatically on digital study cast model 2 dimensions (2D). Hopefully, this digital measurement of PAR index may facilitating orthodontists in analyzing study cast model and able to overcome the need of conventional study cast model storage problem.

This study is collaboration between Department of Orthodontics Faculty of Dentistry, University of Indonesia and Faculty of Computer Science, University of Indonesia.

This study compares manual measurement of PAR index components on conventional study cast model with digital measurement on digital study cast model using PAR index software. The software is currently being developed by Rustamadji, RS (Citation Wisesa HA and Bahriawan R). Out of 11 PAR index components, the software for 6 components had already completed. This study is collaboration between Department of Orthodontics Faculty of Dentistry, University of Indonesia and Faculty of Computer Sciende, University of Indonesia. PAR index components measured including measurement deviation proximal contact in right maxillary buccal segment, maxillary anterior segment, left maxillary buccal segment, right mandibular buccal segment, mandibular anterior segment, and left mandibular buccal segment.

Materials and methods

Study samples are 60 study cast model of pre-orthodontic treatment patients in Orthodontist Clinic of Oral and Dental Hospital Faculty of Dentistry, University of Indonesia that fit with inclusion criteria.[17-19] The inclusion criteria including: study cast model has good and stable heptagon base, not broken, damaged, cracked nor porous, good and stable occlusion/biting, good and complete maxillary and mandibular permanent teeth up to first molar, with malocclusion case Class I, II, III. While the exclusion criteria are if the patient has peg-shaped incisive, premature loss of permanent teeth, premolar agenesis, tooth with crown, bridge, proximal restoration or still has primary teeth.

Instruments and materials used for data input process are: PAR plastic ruler, flat scanner (HP Scanjet G4050), 5.0×4.0×4.0 cm brick block, lather double tape (3M Scotch), PAR index software and 1.0×1.0 m white fabrics cover. This is laboratory experimental study. Independent variables in this study are manual and digital measurement technique, while the dependent variables are PAR index components 1 to 6.

The study carried out by the following steps: after collecting the pre-orthodontic treatment study cast models that fit in the inclusion criteria, the manual measurement PAR index was done using PAR plastic ruler. Next the conventional study cast models were scanned using scanner (HP Scanjet G4050) to obtain 2 dimensions (2D) digital study cast model.[20] The scanning step sequence as follows: the cover of the scanner was removed from the body and the the cover was supported using brick block on both sides, the lather double tapes placed at a predetermined location on the cover of the scanner. These lather double tapes served as adhesion to the study cast model bases. The study cast models were placed with the occlusal surface facing the scanner in parallel with each other. The maxillary study cast model was placed on the left side, while the mandibular on the right side. The scanner connected with computer. While scanning the study cast model, the scanner was covered using white fabrics to prevent light fluorescent from scanner. The scanning study cast model result saved as 2 dimensions (2D) picture in JPEG (Joint Photographic Experts Group) file format. The results cropped one by one using Adobe Photoshop CS6 application.

Furthermore digital measurement of PAR index was carried out on the 2 dimensions (2D) digital study cast models using PAR index software. Intra-observer test was carried out on 10 samples. This test was done by two-times repeated measurement on conventional study cast model as well on 2 dimensions (2D) digital study cast model. The time span between the first and second measurement (t_0, t_1) was two weeks. The samples were chosen randomly with random sampling and blinding to reduce error method of measurement. Inter-observer test also carried out on 10 samples by two examiners. This test was done on conventional study cast model as well on 2 dimensions (2D) digital study cast model. The result of first and second examiners (P_1, P_2) were compared each other. Data analysis used in this study is Kappa agreement and Spearman's correlation test with significance limit $p \leq 0.05$.[21]

Results

Intra and inter-observer test manually and digitally were carried out before statistical analysis. The purpose of intra-observer test is to examine the consistency repeated measurement

with the same technique, while inter-observer test is to obtain compability of manual and digital measurement results from first and second examiners (P_1, P_2). The compability between first and second measurement and also between first and second examiners were analyzed using Kappa agreement with criteria <0.20 (low); 0.21-0.40 (moderate); 0.42-0.60 (adequate); 0.61-0.80 (good); and 0.81-1.00 (very good).[22] Overall, the result of intra and inter-observer tests, manual and digital, compability showed good and very good Kappa agreement interpretation. The result of Kappa agreement analysis on intra and inter-observer tests, manual and digital, compability were shown in table 1 and table 2.

PAR Component Variables (t_0,t_1)	Kappa Agreement Intra-observer Interpretation Manual n = 60	Kappa Agreement Intra-observer Interpretation Digital n = 60
Component 1	0.831 (very good)	0.844 (very good)
Component 2	0.783 (good)	0.737 (good)
Component 3	1 (very good)	0.815 (very good)
Component 4	0.825 (very good)	0.841 (very good)
Component 5	0.815 (very good)	0.737 (good)
Component 6	0.811 (very good)	0.756 (good)

Table 1. Kappa agreement score of intra-observer test on manual and digital measurement. (NB: t_0 = first measurement, t_1 = second measurement)

PAR Component Variables (t_0,t_1)	Kappa Agreement Inter-observer Interpretation Manual n = 60	Kappa Agreement Inter-observer Interpretation Digital n = 60
Component 1	0.804 (very good)	1 (very good)
Component 2	0.800 (very good)	0.783 (good)
Component 3	0.756 (good)	0.804 (very good)
Component 4	1 (very good)	0.808 (very good)
Component 5	0.844 (very good)	0.783 (good)
Component 6	0.756 (good)	0.737 (good)

Table 2. Kappa agreement score of inter-observer test on manual and digital measurement. (NB: P1 = first examiner, P2 = second examiner)

There's no PAR index score 0 and 5 on manual and digital measurement of component 1 (Right Maxillary Buccal Segment). The most data distribution frequency was PAR index score 3 (Table 4). The result Spearman's test on manual and digital measurement PAR index component 1 was significant (p) < 0.001. The correlation score (r) is 0.804 refers to positive with very strong correlation. Zero hypothesis states that there's no difference on manual and digital measurement result of PAR index component 1 score is accepted.

Measurement	PAR index score 0		1		2		3		4		5	
	N	%	n	%	n	%	n	%	n	%	n	%
I. Manual												
Component 1	0	0	1	1.7	12	20	37	61.7	10	16.7	0	0
Component 2	0	0	0	0	0	0	12	20	48	80	0	0
Component 3	0	0	1	1.7	23	38.3	30	50	6	10	0	0
Component 4	0	0	1	1.7	9	15	40	66.7	10	16.7	0	0
Component 5	0	0	0	0	4	6.7	27	45	29	48.3	0	0
Component 6	0	0	1	1.7	9	15	41	68.3	9	15	0	0
II. Digital												
Component 1	0	0	1	1.7	8	13.3	40	66.7	11	18.3	0	0
Component 2	0	0	0	0	0	0	8	13.3	52	86.7	0	0
Component 3	0	0	1	1.7	19	31.7	30	50	10	16.7	0	0
Component 4	0	0	1	1.7	7	11.7	39	65	13	21.7	0	0
Component 5	0	0	0	0	1	1.7	25	41.7	34	56.7	0	0
Component 6	0	0	1	1.7	6	10	39	65	14	23.3	0	0

Table 3. Data distribution frequency of manual and digital measurement on 60 samples.

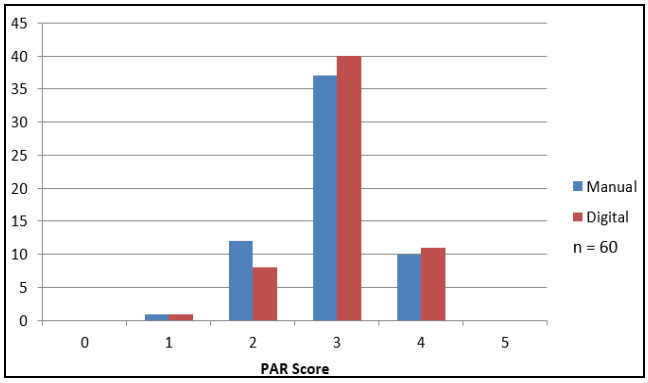

Table 4. Data distribution frequency of manual and digital measurement of right maxillary buccal segment.

PAR = Peer Assessment Rating
PAR score 0 = deviation proximal contact 0-1 mm
PAR score 1 = deviation proximal contact 1,1-2 mm
PAR score 2 = deviation proximal contact 2,1-4 mm
PAR score 3 = deviation proximal contact 4,1-8 mm
PAR score 4 = deviation proximal contact greater than 8 mm
PAR score 5 = impacted teeth

While on component 2 (Maxillary Anterior Segment), there's PAR index score 0 and 5. Data distribution frequency found on PAR index 3 and 4. The most frequency is PAR index score 5 (Table 5). The Spearman's test result on manual and digital measurement PAR index component 2 was significant (p) < 0.001. The correlation score (r) is 0.784 refers to positive with strong correlation. Zero hypothesis states that there's no difference on manual and digital measurement result of PAR index component 2 score is accepted.

There's no PAR index score 0 and 5 on manual and digital measurement of component 3 (Left Maxillary Buccal Segment) (Table 6). The result Spearman's test on manual and digital measurement PAR index component 3 was significant (p) < 0.001. The correlation score (r) is 0.880 refers to positive with very strong

correlation. Zero hypothesis states that there's no difference on manual and digital measurement result of PAR index component 3 score is accepted.

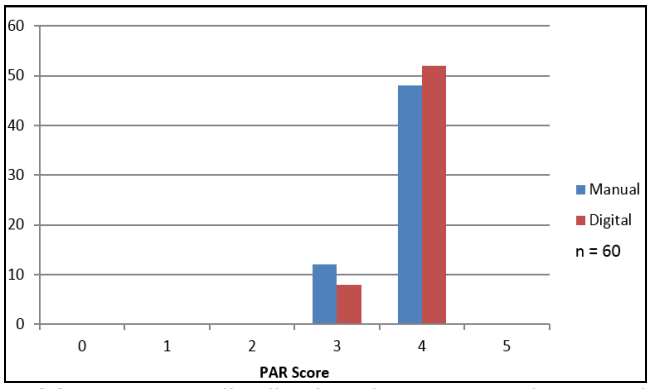

Table 5. Data distribution frequency of manual and digital measurement of maxillary anterior segment.

PAR = Peer Assessment Rating
PAR score 0 = deviation proximal contact 0-1 mm
PAR score 1 = deviation proximal contact 1,1-2 mm
PAR score 2 = deviation proximal contact 2,1-4 mm
PAR score 3 = deviation proximal contact 4,1-8 mm
PAR score 4 = deviation proximal contact greater than 8 mm
PAR score 5 = impacted teeth

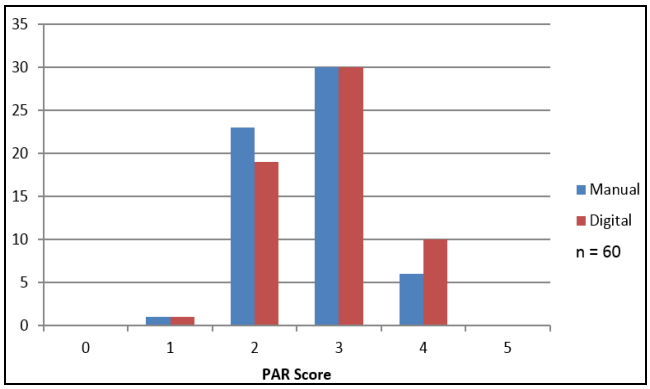

Table 6. Data distribution frequency of manual and digital measurement of left maxillary buccal segment.

PAR = Peer Assessment Rating
PAR score 0 = deviation proximal contact 0-1 mm
PAR score 1 = deviation proximal contact 1,1-2 mm
PAR score 2 = deviation proximal contact 2,1-4 mm
PAR score 3 = deviation proximal contact 4,1-8 mm
PAR score 4 = deviation proximal contact greater than 8 mm
PAR score 5 = impacted teeth

The most data distribution frequency on manual and digital measurement of component 4 (Right Mandibular Buccal Segment) was for PAR index score 3 (Table 7). The result Spearman's test on manual and digital measurement PAR index component 4 was significant (p) < 0.001. The correlation score (r) is 0.842 refers to positive with very strong correlation. Zero hypothesis states that there's no difference on manual and digital measurement result of PAR index component 4 score is accepted.

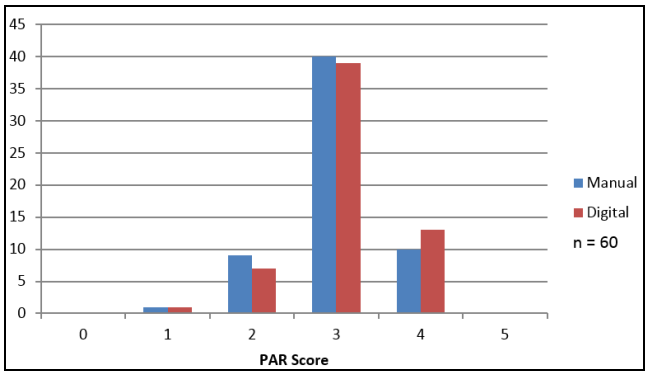

Table 7. Data distribution frequency of manual and digital measurement of right mandibular buccal segment.

PAR = Peer Assessment Rating
PAR score 0 = deviation proximal contact 0-1 mm
PAR score 1 = deviation proximal contact 1,1-2 mm
PAR score 2 = deviation proximal contact 2,1-4 mm
PAR score 3 = deviation proximal contact 4,1-8 mm
PAR score 4 = deviation proximal contact greater than 8 mm
PAR score 5 = impacted teeth

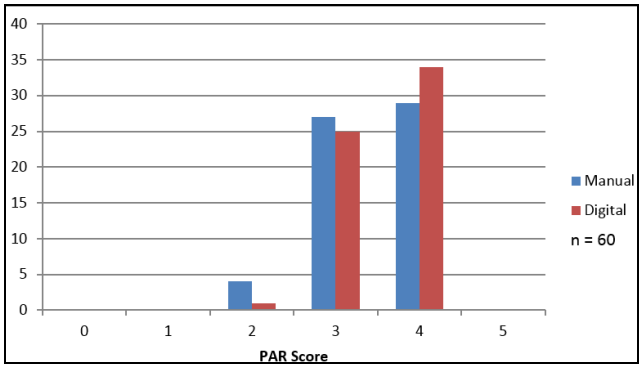

Table 8. Data distribution frequency of manual and digital measurement of mandibular anterior segment.

PAR = Peer Assessment Rating
PAR score 0 = deviation proximal contact 0-1 mm
PAR score 1 = deviation proximal contact 1,1-2 mm
PAR score 2 = deviation proximal contact 2,1-4 mm
PAR score 3 = deviation proximal contact 4,1-8 mm
PAR score 4 = deviation proximal contact greater than 8 mm
PAR score 5 = impacted teeth

Like the previous 4 components, there's no PAR index score 0 and 5 on manual and digital measurement of component 5 (Mandibular Anterior Segment) (Table 8). The result Spearman's test on manual and digital measurement PAR index component 4 was significant (p) < 0.001. The correlation score (r) is 0.790 refers to positive with strong correlation.

Zero hypothesis states that there's no difference on manual and digital measurement result of PAR index component 1 score is accepted.

There's no PAR index score 0 and 5 on manual and digital measurement of component 6 (Left Mandibular Buccal Segment). The most data distribution frequency was PAR index score 3 (Table 9). The result Spearman's test on manual and digital measurement PAR index component 6 was significant (p) < 0.001. The correlation score (r) is 0.820 refers to positive with very strong correlation. Zero hypothesis states that there's no difference on manual and digital measurement result of PAR index component 6 score is accepted.

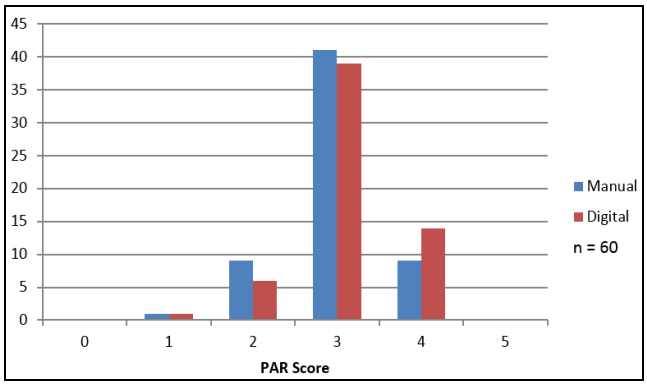

Table 9. Data distribution frequency of manual and digital measurement of left mandibular buccal segment.

PAR = Peer Assessment Rating
PAR score 0 = deviation proximal contact 0-1 mm
PAR score 1 = deviation proximal contact 1,1-2 mm
PAR score 2 = deviation proximal contact 2,1-4 mm
PAR score 3 = deviation proximal contact 4,1-8 mm
PAR score 4 = deviation proximal contact greater than 8 mm
PAR score 5 = impacted teeth

Discussion

Some studies have carried out to examine the accuracy of the digital study cast model measurement compared with the conventional study cast model measurement.[14-16,23-29] Nollet (2004), Paredes, et al. (2005) and Malik, et al. (2009) suggest that the measurement of 2 dimensions photograph is as accurate as manual measurement on conventional study cast model and there's no significantly difference.[16,24,30] These prove that digital study cast model may be used as a valid alternative method and reliable for diagnosis determining and treatment planning.

The result of intra and inter-observer test on manual and digital measurement of PAR index from statistical analysis Kappa agreement show good and very good interpretation. The discrepancies between the manual and digital measurement of PAR index may be caused by different direction or angle measurement, different reference points measured, time and examiners exhaustion factors. Difficulty on determining same reference points also reported by Mullen, et al. (2007).[19]

Data distribution frequency shows that there's no PAR index score 0 and 5 out of 60 samples. Although the samples may not represent overall patients of Orthodontic Clinic of Oral and Dental Hospital Faculty of Dentistry, University of Indonesia, but it may be concluded that most of the patients have considerable degree of malocclusion severity that need orthodontic treatment.

Because of the unbalance distribution data between each components of PAR index on this study, it's impossible to carried out Chi-Square comparative test.[21] Therefore the correlation test carried out for this study was using Spearman's correlation test. The Spearman's test result on manual and digital measurement PAR index component 1 to 6 were significant ($p<0.05$). These result were in line with previous studies that state that there's no significant difference between manual measurement on conventional study cast model and on 2 dimensions photograph.[16,24,30] Similar result of this study with previous studies is because this study use the same way in the making of digital study cast model.

Conclusions

Spearman's correlation score (r) obtained on this study ranging from 0.784-0.880 show that overall each of PAR index components measured have strong correlation between manual and digital measurement. Positive correlation indicates that there's parallel correlation between manual and digital measurement of PAR index. Thereby, the bigger correlation score of PAR index manual measurement would be followed with excalation of PAR index digital measurement correlation score.

Zero hypothesis stating that there's no difference on manual and digital measurement result of PAR index component 1 to 6 score is admissible. According to Spearman's correlation test, correlation strength (r) indicates that there's

no 1 absolute score. It is likely because of the PAR index software made by Department of Orthodontics Faculty of Dentistry, University of Indonesia and Faculty of Computer Science, University of Indonesia still require further improvement.

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Declaration of Interest

The authors report no conflict of interest.

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