Evaluating clear aligners: part 2

Following the introduction to her study, in part two of this series, **Raya Karaganeva** presents her methods and results

The data presented in this study were collected from S4S Dental Laboratory, Sheffield. The orthodontic treatment applied to all patients was Smilelign clear thermoplastic aligners.

All selected cases were assessed in the presence of the laboratory technical director and the information taken was recorded anonymously. Patient's confidentiality was ensured during the whole process by identifying subjects and casts with a number.

Fig. 2.1: Example of pre-treatment casts and post-treatment upper stereolithographic model

Fig. 2.4: Measuring contact points and overjet discrepancies with PAR ruler

PAR score calibration

Following the PAR index method 30 cases were assessed (Richmond et al., 1992a). A PAR ruler was used to measure the pre-treatment stone models (Ultrarock - KALABHAI supplied by John Winter, Halifax, UK) and the last 3D printed models of each case (assuming that the last aligner will determine the post-treatment position of the teeth) (Fig. 2.1). The resin models are made of E-denstone 3SPTM material and were printed by ULTRA 3SPTM Ortho. Avoiding any bias, the cases were randomly selected from the dental laboratory storage and all of them were completed in the past year and a half. It is known that the cases were sent to the laboratory from more than 10 different clinicians.

Initially, the PAR components for 10 cases were assessed (Figure 2.2) and recorded on Excel PAR Scoring Sheet by two examiners, an undergraduate student and a technician calibrated in PAR index.

Table 2.1: PAR score index

	Component	Scoring system			Weighting
1	Upper and lower anterior segments (Crowding and spacing 3 - 3*)	Score: 0 = 0 to 1; 1 = 1.1 to 2; 2 = 2.1 to 4; 3 = 4.1 to 8; 4 = > 8; 5 = impacted teeth			1
2	Left and right buccal occlusion (Fit of the teeth in the 3 planes of space 4 - 8* and 3 Ant-posterior only)	Ant-posterior: 0 None; 1 < 1/2 unit dis*; 2 = 1/2 unit dis	Transverse: 0 No xbite*; 1 Xbite tend* ≥ 1t; 2 1 tooth in xb*; 3 > 1 tooth in xb; 4 > 1 tooth in sb*	Vertical: 0 None; 1 Open bite 2t* >2mm	1
3	Overjet (Positive and number of teeth in crossbite 3 - 3*)	Overjet (mm): 0 0 to 3; 1 3.1 to 5; 2 5.1 to 7; 3 7.1 to 9; 4 > 9	Reverse overjet (negative): 0 No teeth in xbite; 1 Edge to edge; 2 1 tooth in xbite; 3 2 teeth in xbite; 4 > 2 teeth in xbite		6
4	Overbite (Overbite and open bite relative to lower incisor 2 - 2*)	Overbite: 0 < 1/3; 1 1/3-2/3; 2 > 2/3; 3 ≥ FTC*	Open bite (mm): 0 No open bite; 1 ≥ 1; 2 1.1 to 2; 3 2.1 to 4; 4 > 4.1		2
5	Centre line (Relative to width lower incisor)	Centre line: 0 ≤ 1/4; 1 1/4 - 1/2; 2 >1/2			4

Three months later, only the technician PAR scored the next 20 cases and the data were sent to the student for analysis.

The criteria for measuring the PAR scores are presented in Table 2.1.

The cases were categorised into simple group (T1) with pre-treatment scores of 29 or lower and complex group (T2) with pre-treatment scores of 30 and over.

The weighted scores of pre- and post treatment for whole sample (T3) allowed:

- Calculations of the reduction between start and finish treatment scores
- Nomogram representation of the PAR scored sample
- Calculations of the percentage improvement for each case using the following equation:

$$\frac{\text{Pre TX score - Post TX score}}{\text{Pretreatment}} \times 100 = \%\ \text{reduction}$$

Referring to Richmond et al. (1992a), the results were classified into:

1. 'Worse or no different' - less than a 30% reduction in weighted PAR score
2. 'Improved' - greater than or equal to 30% reduction in weighted PAR score
3. 'Greatly improved' - generally a reduction of 22 weighted PAR points.

Additional information recorded:

- The length of the treatment was estimated by knowing the total number of aligners for each patient, as each Smilelign aligner is being worn for three weeks (eg a treatment of eleven clear aligners for an upper arch would be thirty-three weeks long)
- Patient's gender was assumed from their names. In order to record the correct information, a confirmation from the clinicians was needed in some cases
- Angle's jaw classification was obvious when occluding the upper and lower casts on PAR scoring
- Information about IPR was taken from the patient's prescription.

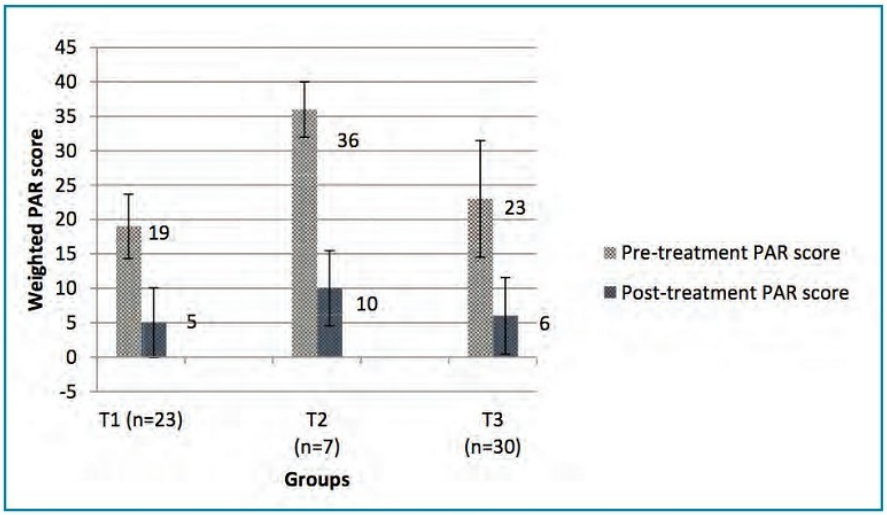

Fig. 3.1: Mean weighted pre- and post-treatment PAR scores for T1, T2 and T3 (error bars representing the SD)

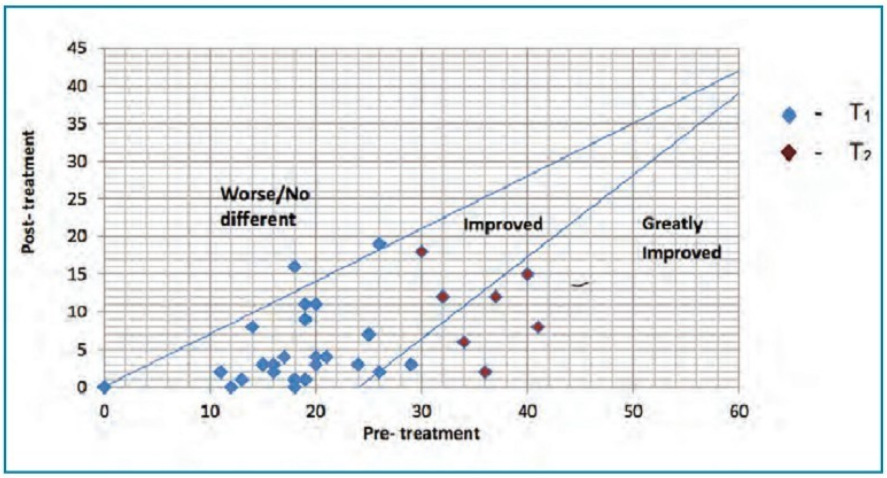

Fig. 3.2: Nomogram with pre- and post- treatment PAR scores and improvement categories. The whole sample is represented by T1 and T2

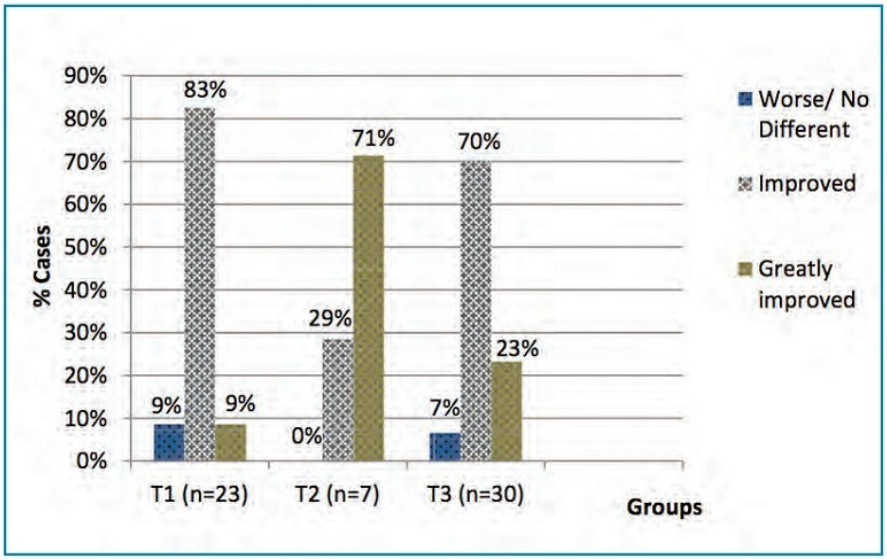

Fig. 3.3: Percentage of cases from T1, T2 and T3 in relation to PAR categories of improvement.

- Approximately 12 hours were spent on obtaining the data.

Dental laboratory audit

An audit in the same laboratory looked at the frequency of interventions amongst 200 randomly selected patients. One hundred cases were treated with fewer than ten aligners and one hundred cases with more than ten aligners. According to the laboratory's policy, the former is classified as simple cases and the latter as complex. Then a sample of five simple and five complex cases was taken. Patient's gender, reasons for a return and the outcome of the treatments were recorded. All of them were completed in different dental practices.

Further analysis of PAR scoring

Analyses of the mean and standard deviation (SD) values for the variables were used to categorise sample improvement. The results as opposed to pre-treatment scores for T1, T2 and T3 were compared. Any trends in the additional information recorded were noted. The variables for each PAR component were useful to determine the least and most improved component after treatment. In this study, only the weighted values were used for evaluation. Undertaking laboratory audit was intended in order to see how many cases from a 200 sample were returned and what refinements were mainly required.

Results - PAR score data

Following the data collection for the sample of 30 cases, 23 had weighted PAR score equal or less than 29 (T1) and 7 had an initial score equal or greater than 30 (T2). Figure 3.1 shows the weighted PAR score results for the sample at the beginning and final stage. The average pre-treatment score for T3 was 23 PAR points and dropped

Table 3.1: Mean ± SD Reduction and Percentage Reduction of weighted scores in PAR index.			
	T1 (n=23)	T2 (n=7)	T3 (n=30)
Reduction	14 ± 5.82	25 ± 7.61	17 ± 8.23
% Reduction	74 ± 24.55	70 ± 17.43	73 ± 22.86

Table 3.2: Mean ± SD PAR index weighted scores and improvement of individual PAR components for the whole sample			
PAR Components	Pre-treatment	Post-treatment	Reduction
Anterior segment			
Upper	5 ± 2.13	0 ± 0.18	5 ± 2.20
Lower	4 ± 2.72	0 ± 0.78	4 ± 2.99
Buccal Occlusion			
Antero-posterior	2 ± 1.22	2 ± 1.12	0 ± 0.45
Transverse	1 ± 1.69	0 ± 1.28 0	0 ± 1.28
Vertical	0	0	0
Overjet	7 ± 5.32	2 ± 3.69	5 ± 4.66
Overbite	1 ± 1.46	0 ± 1.01	1 ± 1.04
Centre Line	2 ± 2.73	1 ± 1.94	1 ± 2.19

Table 3.3: Sample description in relation to gender, jaw classification and IPR					
	T1(n=23) n%		T2(n=7) n%		T3(n=30)
	n	%	n	%	n %
Gender					
Male	14	60	5	70	19 64
Female	9	40	2	30	11 36
Jaw class					
Class I	16	70	4	57	20 67
Class I I	5	21	3	43	8 27
Class I I I	2	9	0	0	2 6
IPR	12	52	4	57	16 54

to 6 points, which shows an initial low classified as 'Improved', where 83% (n=19) belonged to T1 and 29% (n=2) to T2. 'Greatly improved' cases were 23% (n=7): T2 (n= 5) and only two were from the simple case group.

Two cases reached post-treatment PAR score of zero and 16 more attained less than five points after treatment. Hence, 60 % (T1 n=15, T2 n=1) of T3 accounted for cases with 0-5 finish weighted PAR score and were considered to have an ideal occlusion. Table 3.1 shows that the percentage reduction for the three groups was similar but the greatest percentage improvement (74%) was in T1 compared to 70% of T2 and 73% for the whole sample. However, T1 demonstrated 11 PAR points less reduction compared to the second group. The average PAR score reduction for T3 was 17 ± 8.23 with minimum of 2 and maximum of 34.

PAR index weighted scores for each PAR component are illustrated in Table 3.2. Upper and lower anterior segments achieved highest improvement to zero post-treatment PAR points. This leads to 0-1 mm discrepancy after treatment in all patients. However, maximum 10 points per each anterior segment could be allocated. At the start, the sample showed a mean value of 5 ± 2.13 for the upper and 4 ± 2.72 for the lower. In addition, the

overjet reduction (5 ± 4.66) had a great contribution to the overall improvement.

Two cases had a negative score as they were with reverse overjet. No significant reduction was achieved for T3 in the buccal occlusal component, especially in anteroposterior plane (pre-treatment 2 ± 1.22 and post-treatment 2 ± 1.12). The overbite and centre line achieved slight improvement.

The sample characteristics are presented in Table 3.3. Out of 30 patients, 19 were females and 11 were males. There was no balance between gender, length and complexity of the treatments.

The average percentage reduction for Class I (76%) was higher than Class II (63%). In this sample, 6% (n=2) of the patients were Class III and they belonged to T1.

One of them improved its negative overjet to zero PAR points and was categorised as 'Greatly improved'. The other one was 'Improved' and showed the highest reduction in the anterior segment.

IPR treatment was performed for 54% of the

patients. For T3 the average IPR per patient was 0.8mm ± 1.02, for T1 was 0.9mm ± 1.02 and for T2 was 0.7mm ± 1.07. The maximum IPR per tooth was 0.25 mm.

The average treatment of T1 was 6 ± 1.95 months and it did not differ greatly from T2 (8 ± 1.98). The shortest treatment was 3 months and the longest was 10; T3 - 6 ± 2.07 months. This equals to the average of eight aligners (both upper and lower) per person. However, Class I cases displayed the shortest treatment of six months and Class III were treated the longest, 10 months.

Dental laboratory audit

36% (n=71) of 200 sample were returned to the laboratory and required mid-treatment adjustments (36 simple and 35 complex cases). It was noticed that the majority of the patients were female. Four out of the ten patients had interventions for both upper and lower aligners. The predominant reasons for the return were additional refinements such as adding an extra aligner to the treatment, IPR before proceeding to the next stage or re-making of the retainer. Also, in four cases new impressions had to be taken at midtreatment so the next aligners to be replaced. So