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Quality of Orthodontic Appliances from Government Dental Laboratories in Selangor

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ABSTRACT

This is a pilot study to evaluate the quality of orthodontic appliances issued by government dental laboratories in Selangor and factors which may influence quality. Removable and fixed orthodontic appliances issued from all four main orthodontic clinics in Selangor were rated for 'good', 'satisfactory' or 'poor' quality in adherence to design, fit, retention, thickness, absence of porosity and soldering over a 8-month period by orthodontists. The sample comprised appliances fabricated by 4 trainee and 14 trained technicians issued to 365 patients from Tanjong Karang (10.4%), Kajang (31.2%), Klang (52.3%) and Shah Alam (6.0%) in Selangor. The overall quality of removable appliances was high with mean 'good' quality above 87% and 'poor' quality in less than 5%. Quality was generally lower in transpalatal arches and quadhelix, and 'good' quality in only 80% soldering. Overall, junior technicians (0.1-3 years in service) had marginally higher 'good' quality rating than senior technicians (>3 years in service), although they produced less than half the output of seniors. Trainees scored lower 'good' quality rating in all aspects compared with trained technicians. Shah Alam technicians consistently scored much lower 'good' quality rating in all aspects compared with other centres, although output from Shah Alam was the lowest and had the most equitable workload distribution. There was large disparity in output from individual technicians although workload did not appear to be associated with quality.

Key Words: Orthodontic appliances, Quality, Dental laboratories, Government.

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INTRODUCTION

Unsatisfactory quality of orthodontic appliances may result in poor compliance to wear in patients. Poorly fabricated appliances often need to be modified or redone resulting in wastage of materials, clinical time, patient inconvenience and may jeopardize treatment outcomes.[1]

Generally, dental technicians attached to government orthodontic clinics are responsible for preparing study models and fabricating dentures, splints and orthodontic appliances. The amount of workload is generally distributed among all the technicians although it is the prerogative of the Dental Officer-in-charge in each clinic to set the duties and annual performance targets for technicians. However, senior technicians and trained post-basic orthodontic technicians may assume more cases. In the Ministry of Health Malaysia (MOH), there is a quality assurance (QA) system in MS ISO9000 whereby clinicians are required to fill a feedback form to the laboratory when appliances were not fit to be issued and had to be remade. This practice was not consistently carried out by the clinicians. The feedback forms were usually filed without any action being taken thus, had little or no impact on the technicians.

Quality assurance of appliances is directly related to customer satisfaction and this is indirectly related to longer waiting-room time for other patients when fitting of appliances take longer than expected.[2] There have been complaints that some senior technicians consistently produce poor quality appliances and junior technicians produce better work or vice versa. There were many grouses that some technicians were over-burdened with work due to preferential selection of technicians producing excellent work by orthodontists. So far, these perceptions were not evidence-based and if indeed were true we need to identify where the

weaknesses are. Following the recent introduction of several Key Performance Indicators (KPI) by MOH in government orthodontic clinics, it seems timely to carry out an evaluation of the quality of orthodontic appliances delivered by our local dental laboratories since there has not been any previous study carried out in all orthodontic clinics in Selangor and there is no KPI on quality for dental technicians.[3]

Hence, this is a pilot study to assess the quality of orthodontic appliances produced from dental laboratories in Selangor, and evaluate factors such as technician experience and workload that may influence quality.

METHODOLOGY

This is a cross-sectional study of all patients issued with removable and fixed orthodontic appliances fabricated in dental laboratories in all the four main orthodontic clinics in the state of Selangor from February to September 2009. The four main orthodontic clinics in Selangor are in Klang, Kajang, Shah Alam and Tanjong Karang. The new orthodontic clinic in Sri Kembangan was excluded as it was not fully functioning at the time of the study. There were two orthodontists in Klang and Kajang, and one each in Shah Alam and Tanjong Karang.

Inclusion criteria

1. All removable and fixed orthodontic appliances fabricated in dental laboratories for the orthodontic clinics during the study period from February – September 2009.
2. All orthodontic appliances fabricated by technicians from the four clinics, including trained and trainee technicians.

Exclusion criteria

1. Orthodontic appliances issued by visiting orthodontist in Rawang dental clinic.
2. Dentures, splints and other non-orthodontic appliances.

Data collection and analysis

This was a convenience sample size based on the mean annual output of appliances of the preceding year from the clinics. There is no standard or predictable monthly output of appliances as the demand depends on the need in individual patients. Data collection for eight months (February-September) was deemed an adequate sample size for analysis in a pilot study. Seniority in government service was equated with working experience and hence skill. This may be a factor influencing the quality of appliances produced. Therefore, technicians were arbitrarily categorized into three groups; namely 'trainees', 'junior' and 'senior' technicians, according to their years in service. Technicians with 0.1-3 years of service were categorized as junior technicians and those with more than 3 years of service were grouped as senior technicians. The quality of appliances fabricated and work output were compared between the groups.

All technicians were not aware that their work was being evaluated for the study. The quality of appliances was evaluated by individual orthodontists after the appliance has been assessed outside and inside the patient's mouth. This was recorded in the data collection form by Dental Surgery Assistants (DSA). All completed forms from the respective clinics were sent to Klang where two Dental Officers were responsible for data entry and processing. Descriptive analysis and cross-tabulations were carried out in SPSS version 12.0. Chi-square tests where appropriate were carried out to test for significance between the variables. Statistical significance was set at $p<0.05$.

Definition of orthodontic appliances

1. URA: Includes all active upper or lower removable appliances fabricated in acrylic. Active components such as wire labial bows, clasps, springs and screws may be incorporated in the acrylic. URA is usually heat-cured although some may be cold-cured.
2. Retainer: Acrylic retainers are fabricated in acrylic with wires and clasps incorporated. This is usually cold-cured with orthoresin. Plastic retainers are fabricated from thermal, vacuum-formed plastic plates without wire components.
3. Functional appliance (FA): This may be a one-piece appliance like activators, bionators, habit-breakers or two-piece appliance like the Clark's Twin Block. Functional appliances require mounting of the working models in correct occlusion, and usually incorporate

wires, clasps, screws and are fabricated in heat-cured acrylic.

4. Trans-palatal arch (TPA): This is a fixed (non-acrylic) appliance which requires precision wirework and
5. Quadhelix: This is a fixed expansion appliance (non-acrylic) which requires precision wirework and soldering to the orthodontic bands.

Rating of quality of appliances

Quality was rated on a simple scale of 'good, satisfactory, poor'. 'Good' means no flaws and no adjustments required; 'satisfactory' means minor flaws which are acceptable and adjustable; and 'poor' means major flaws which needs considerable modification and may have potential problems with patient wear or have to be rejected and requiring re-fabrication of appliance. Removable appliances like URA, retainers and FA were rated in five aspects; that is adherence to design specifications, fit, retention, thickness and porosity. TPA and Quadhelix are metal appliances and were rated in four aspects; that is adherence to design specification, fit, retention and soldering. Rating in each type of appliance was recorded for 'per patient' and not 'per appliance'. Hence, if two retainers were issued to one patient, the mean rating was recorded for that patient.

Table 1. Appliances fabricated in different Centre

	Appliance type						
Centre	**URA**	**Retainer acrylic**	**Retainer plastic**	**Functional appliance**	**TPA**	**Quad Helix**	**Total**
Kajang	20 (17.5%)	69 (60.5%)	10 (8.8%)	0	14 (12.3%)	1 (0.9%)	114 (31.2%)
Tanjong Karang	4 (10.5%)	18 (47.4%)	2 (5.3%)	3 (7.9%)	10 (26.3%)	1 (2.6%)	38 (10.4%)
Klang	24 (12.6%)	96 (50.3%)	30 (15.7%)	30 (15.7%)	7 (3.7%)	4 (2.1%)	191 (52.3%)
Shah Alam	1 (4.5%)	14 (64.6%)	3 (13.6%)	1 (4.5%)	2 (9.1%)	1 (4.5%)	22 (6.0%)
Total	49 (13.4%)	197 (54%)	45 (12.3%)	34 (9.3%)	33 (9.0%)	7 (1.9%)	365 (100%)

n (%)

Table 2. Adherence to design specification in appliances and technician rating

Appliance	**Adherence to design specification**				
	Ratings good	**Satisfactory**	**Poor**	***not scored**	**Total**
URA	43 (87.8%)	4 (8.2%)	0	2 (4.1%)	49 (13.4%)
Acrylic Retainer	179 (90.9%)	17 (8.6%)	1 (0.5%)	0	197 (54%)
Plastic Retainer	44 (97.8%)	1 (2.2%)	0	0	45 (12.3%)
Functional Appliance	31 (91.2%)	2 (5.9%)	1 (2.9%)	0	34 (9.3%)
TPA	27 (81.8%)	5 (15.2%)	0	1 (3%)	33 (9.0%)
Quadhelix	4 (57.1%)	2 (28.6%)	0	1 (14.3%)	7 (1.9%)
Technicion group					
Trainee	23 (82.1%)	3 (10.7%)	1 (3.6%)	1 (3.6%)	28
Junior Technician	98 (94.2%)	4 (3.8%)	0	2 (1.9%)	104
Senior Technicion	207 (88.8%)	24 (10.3%)	1 (0.4%)	1 (0.4%)	233
Total	**328 (89.9%)**	**31 (8.5%)**	**2 (0.5%)**	**4 (1.1%)**	**365 (100%)**

*4 appliances were not graded

RESULTS

The sample comprised appliances in a total of 365 patients; 38 (10.4%) from Tanjong.Karang, 114 (31.2%) from Kajang, 191 (52.3%) from Klang and 22 (6.0%) from Shah Alam. All appliances were fabricated by a total of 4 trainee and 14 trained technicians; 3 from Tanjong.Karang, 8 from Klang, 3 from Kajang and 4 from Shah Alam. Appliances fabricated in different Centres (Table 1).

The majority of appliances issued were retainers (66.3%), followed by URA (13.4%), FA (9.3%), TPA (9.0%) and quadhelix (1.9%). Klang issued the highest number of URA (49%), followed by Kajang (40.8%), Tanjong.Karang (8.2%) and Shah Alam (2%). Klang also issued the highest number of

acrylic retainers (48.7%) followed by Kajang (35%), Tanjong.Karang (9.1%) and Shah Alam (7.1%). Adherence to Design specification (Table 2).

The mean rating for 'good' adherence to design was 89.9% and 0.5% had 'poor' rating. Plastic retainers had the best adherence to design specifications (97.8%), followed by FA (91.2%), acrylic retainers (90.9%), URA (87.8%), TPA (81.8%) and quadhelix (57.1%). 'Poor' adherence to design was recorded only in FA (2.5%) and acrylic retainers (0.3%). Kajang had the highest 'good' rating for design specification (98.2%), followed by Klang (93.2%), Tanjong Karang (86.8%) and Shah Alam (22.7%). Only Shah Alam had 'poor' rating (9%) in this aspect. Junior technicians had the highest percentage 'good' rating (94.2%), followed by seniors (88.8%) and trainees (82.1%) in design adherence. Quality of Fit (Table 3).

Table 3. Quality of 'Fit' in appliances and technician rating

Appliance	**Quality of Fit**				
	Ratings good	**Satisfactory**	**Poor**	***not scored**	**Total**
URA	43 (87.8%)	4 (8.2%)	0	2 (4.1%)	49 (13.4%)
Acrylic Retainer	176 (89.3%)	16 (8.1%)	5 (2.5%)	0	197 (54%)
Plastic Retainer	41 (91.1%)	3 (6.7%)	1 (2.2%)	0	45 (12.3%)
Functional Appliance	28 (82.4%)	5 (14.7%)	1 (2.9%)	0	34 (9.3%)
TPA	24 (72.7%)	7 (21.2%)	1 (3.0%)	1 (3%)	33 (9.0%)
Quadhelix	4 (57.1%)	2 (28.6%)	0	1 (14.3%)	7 (1.9%)
Technicion group					
Trainee	22 (76.6%)	4 (14.3%)	1 (3.6%)	1 (3.6%)	28
Junior Technician	96 (92.3%)	5 (4.8%)	1 (1.0%)	2 (1.9%)	104
Senior Technicion	198 (85.0%)	28 (12.0%)	6 (2.6%)	1 (0.4%)	233
Total	**316 (86.6%)**	**37 (10.1%)**	**2 (0.5%)**	**4 (1.1%)**	**365 (100%)**

*4 appliances were not graded

Table 4. Quality of Retention in appliances and technician rating

Appliance	**Quality of Fit**				
	Ratings good	**Satisfactory**	**Poor**	***not scored**	**Total**
URA	41 (83.7%)	5 (10.2%)	1 (2.0%)	2 (4.1%)	49 (13.4%)
Acrylic Retainer	176 (89.3%)	18 (9.1%)	3 (1.5%)	0	197 (54%)
Plastic Retainer	41 (91.1%)	2 (4.4%)	2 (4.4%)	0	45 (12.3%)
Functional Appliance	29 (85.3%)	2 (5.9%)	2 (8.8%)	0	34 (9.3%)
TPA	28 (84.8%)	2 (6.1%)	1 (3.0%)	2 (6.1%)	33 (9.0%)
Quadhelix	5 (71.4%)	1 (14.3%)	0	1 (14.3%)	7 (1.9%)
Technicion group					
Trainee	25 (89.3%)	2 (7.1%)	1 (3.6%)	0	28 (7.7%)
Junior Technician	97 (93.3%)	3 (2.9%)	2 (1.9%)	2 (1.9%)	104 (28.5%)
Senior Technicion	198 (85.0%)	25 (10.7%)	7 (3.0%)	3 (1.3%)	233 (63.8%)
Total	**320 (87.7%)**	**30 (8.2%)**	**10 (2.7%)**	**5 (1.4%)**	**365 (100%)**

*5 appliances were not graded

Mean rating of 'good' fit was 86.6% with 'poor' fit in 2.2% appliances. Plastic retainers had the best fit (91.1%), followed by acrylic retainers (89.3%), URA (87.8%), FA (82.4%), TPA (72.7%) and quadhelix (57.1%). URA and quadhelix were all rated either satisfactory or good with none of poor fit. Among the centres, Kajang had the highest percentage of 'good' quality of fit (98.2%) and Shah Alam the lowest (13.6%). Shah Alam also had the highest percentage for 'poor' fit (22.7%). 'Good' quality was highest in junior technicians (92.3%), followed by seniors (85%) and trainees (78.6%). 'Poor' rating was 1% in junior technicians, 2.6% in seniors and 3.6% in trainees. Quality of Retention (Table 4).

Mean for 'good' quality retention was 87.7% and for 'poor' quality was 2.7%. Retention was best in plastic retainers (91.1%), followed by

acrylic retainers (89.3%), FA (85.3%), TPA (84.8%), URA (83.7%) and quadhelix (71.4%). 'Poor' retention was highest in FA (8.8%), followed by plastic retainers (4.4%), TPA (3.0%), URA (2%) and acrylic retainers (1.5%). Kajang had the highest percentage of good retention (98.2%) and lowest in Shah Alam (13.6%). Shah Alam had the highest percentage of 'poor' retention (9.1%). 'Good' rating was highest in junior technicians (93.3%), followed by trainees (89.3%) and seniors (85%). 'Poor' quality was highest in trainees (3.6%). Appropriate Thickness (Table 5).

Table 5. Appropriate thickness in removable appliances and technician rating

Appliance	Quality of Thickness				
	Ratings good	Satisfactory	Poor	*not scored	Total
URA	44 (89.8%)	1 (2.0%)	2 (4.1%)	2 (4.1%)	49 (15.1%)
Acrylic Retainer	181 (91.9%)	10 (5.1%)	6 (3.0%)	0	197 (60.6%)
Plastic Retainer	45 (100%)	0	0	0	45 (13.8%)
Functional Appliance	27 (79.4%)	6 (17.6%)	0	1 (2.9%)	34 (10.5%)
Technicion group					
Trainee	21 (91.3%)	1 (4.3%)	1 (4.3%)	0	23
Junior Technician	86 (93.5%)	4 (4.3%)	1 (1.1%)	1 (1.1%)	92
Senior Technicion	190 (90.5%)	12 (5.7%)	6 (2.9%)	2 (1.0%)	210
Total	**297 (91.4%)**	**17 (5.2%)**	**8 (2.5%)**	**3 (0.9%)**	**325 (100%)**

*3 appliances were not graded

Note TPA and Quadhelix are excluded (n=40)

Table 6. Absence of Porosity in removable appliances and technician rating

Appliance	Quality of Fit				
	Ratings good	Satisfactory	Poor	*not scored	Total
URA	46 (93.9%)	1 (2.0%)	0	2 (4.1%)	49 (15.1%)
Acrylic Retainer	181 (91.9%)	7 (3.6%)	8 (4.1%)	1 (0.5%)	197 (60.6%)
Plastic Retainer	44 (97.8%)	1 (2.2%)	0	0	45 (13.8%)
Functional Appliance	31 (91.2%)	2 (5.9%)	0	1 (2.9%)	34 (10.5%)
Technicion group					
Trainee	21 (91.3%)	1 (4.3%)	1 (4.3%)	0	23
Junior Technician	86 (93.5%)	3 (3.3%)	2 (2.2%)	1 (1.1%)	92
Senior Technicion	195 (92.9%)	7 (3.3%)	5 (2.4%)	3 (1.4%)	210
Total	**302 (92.9%)**	**11 (3.4%)**	**8 (2.5%)**	**4 (1.2%)**	**325 (100%)**

*4 appliances were not graded

Note: TPA and Quadhelix are excluded (n=40)

Mean 'good' rating for thickness was 91.4% with 'poor' quality in 2.5%. Among the removable appliances, FA's had the lowest percentage of 'good' rating (79.4%). 'Good' rating was highest in Kajang (99%) and lowest in Shah Alam (15.8%). Shah Alam had the highest percentage of 'poor' quality (31.6%) and none from Kajang and Tanjong Karang. 'Poor' rating was 1.1% in junior technicians, 2.9% in senior technicians and 4.3% in trainees. Absence of Porosity (Table 6).

Mean rating of 'good' quality with no porosity was 92.9% with less than 3% of 'poor' quality. URA had less porosity than acrylic retainers. There was no URA, plastic retainers or FA with poor quality. Kajang had the highest percentage of 'good' quality (98%) and lowest in Shah Alam (15.8%). Shah Alam also had the highest percentage of 'poor' quality (36.8%). 'Poor' quality was less than 2.5% in trained technicians and 4.3% in trainees. Quality of Soldering (Table 7).

Mean 'good' quality soldering was 80% and 'poor' in about 5%. Quadhelix had less good quality soldering (71.4%) compared with TPA (81.8%). Kajang had the highest percentage 'good' soldering (93.3%), followed by Tanjong Karang (90.9%) and Klang (72.7%). Shah Alam had the highest 'poor'

quality soldering (66.7%). Trainee technicians had less 'good' soldering (60%) compared with trained technicians (>82%). Mean rating for quality in all aspects for appliances, technicians and centres (Figures 1, 2 and 3).

Table 7. Quality of soldering in TPA and Quadhelix and technician rating

Appliance	Adherence to design specification				
	Ratings good	**Satisfactory**	**Poor**	***not scored**	**Total**
TPA	27 (81.8%)	2 (6.1%)	1 (3.0%)	3 (9.1%)	33
Quadhelix	5 (71.4%)	1 (14.3%)	1 (14.3%)	0	7
Technicion group					
Trainee	3 (60.0%)	1 (20.0%)	0	1 (20.0%)	5
Junior Technician	10 (83.3%)	0	1 (8.3%)	1 (8.3%)	12
Senior Technicion	19 (82.6%)	2 (8.7%)	1 (4.3%)	1 (4.3%)	23
Total	**32 (80.0%)**	**3 (7.5%)**	**2 (5.0%)**	**3 (7.5%)**	**40**

*3 appliances were not graded

Note: Removable appliances are excluded (n=325)

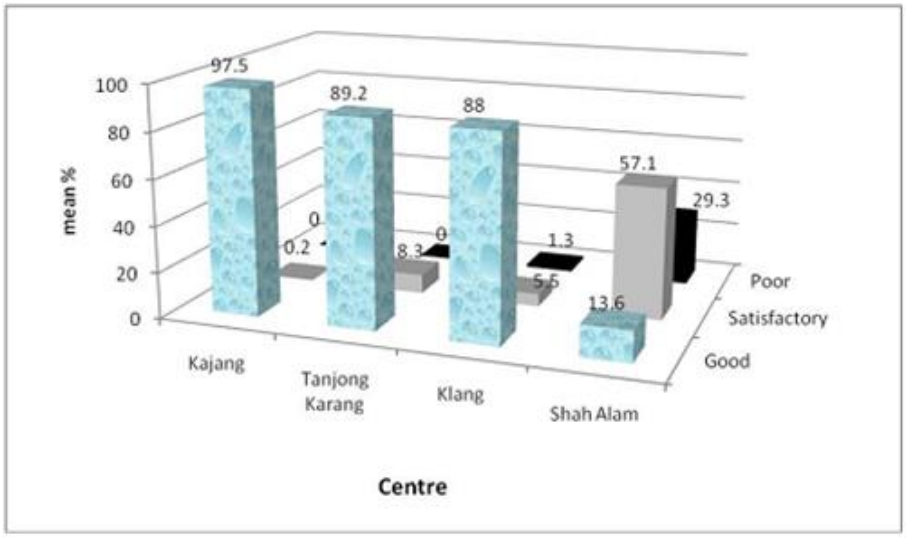

Figure 2. Mean rating in all aspects of quality in different centres

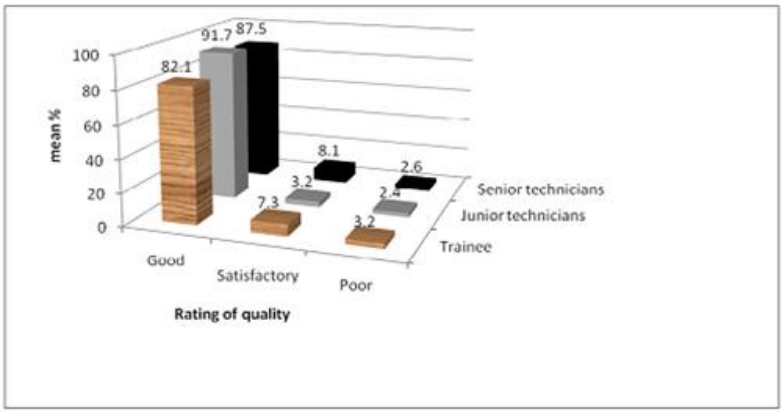

Figure 2. Mean rating in all aspects of quality in technician groups

'Good' quality was above 88% in all centres except Shah Alam (13.6%). Poor quality was highest in Shah Alam (29.3%) compared with other centres (<1.3%). Junior technicians had highest 'good' rating followed by senior technicians and trainees. Overall 'poor' quality was less than 4% with highest

percentage in trainees. 'Good' quality was highest in plastic retainers (95.6%) and lowest in quadhelix (64.2%). Overall poor quality was less than 4% in all appliances. Work output and years in service in individual technicians (Figure 4).

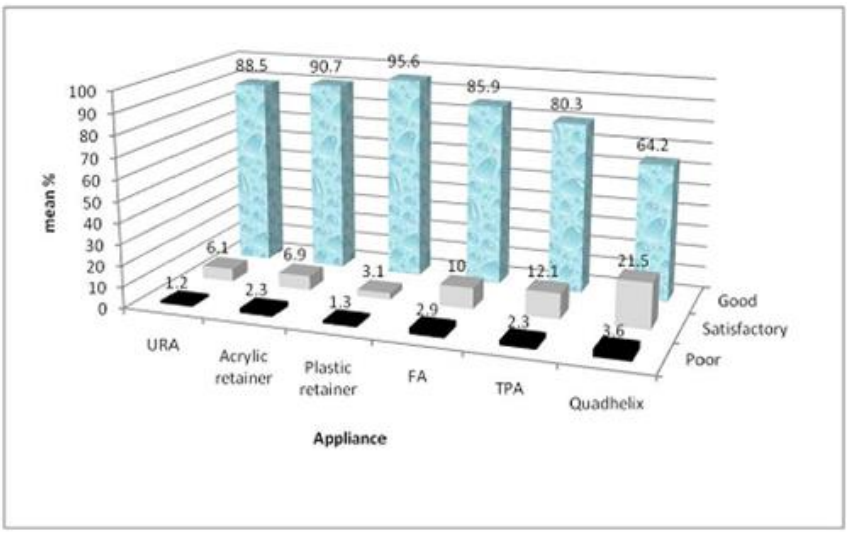

Figure 3. Mean rating in all aspects of quality in different appliances

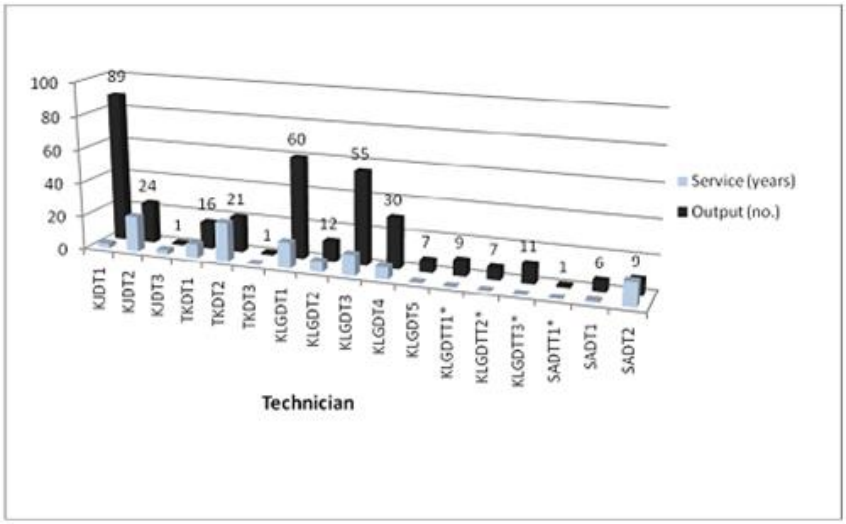

Figure 4. Work output and years in service of individual technicians

Note: *Trainee technicians

Centre	Technicians
Kajang	KJDT1, KJDT2, KJDT3
Tanjung Karang	TKDT1, TKDT2, TKDT3
Klang	KLGDT1, KLGDT2, KLGDT3, KLGDT4, KLDGT5, KLDGTT1, KLDGDTT2, KLGDTTT3
Shah Alam	SADTT1, SADT1, SADT2

There was large range in output within and between centres. Overall lowest outputs were from Shah Alam. All junior technicians had outputs less than 2% except for KJDT1 who had the highest output (24.4%). The mean output per senior technician was 7.13%.

DISCUSSION

The majority of ratings in all centres (except Shah Alam) for 'good' quality in different aspects were above 85% for removable appliances and above 70% for soldering in fixed appliances respectively.

Al-Adwadhi et al. (2006)[1] reported that 65% of their orthodontic laboratory work met all the gold standards which was comparable the current study 'good' quality. Although Shah Alam had the lowest output it consistently had the lowest percentage of 'good' quality rating in all aspects and had highest percentage of 'poor' quality rating. There were two trained technicians in Shah Alam, their seniority was comparable to other centres and both had reasonably equal distribution of workload. Thus, it appears that technicians in Shah Alam produced lower quality appliances compared to other centres. Trainees generally scored lower than trained technicians for 'good' quality and higher percentages for 'poor' quality rating in all aspects. This is expected as the clinical exposure of trainees in orthodontic appliances is very limited in the Dental Training College. Overall, junior technicians were marginally better than seniors for 'good' quality rating but 'poor' quality percentages were comparable in both groups. This may be due to more supervision of junior technicians by orthodontists compared to senior technicians.

Functional appliances had the lowest 'good' quality and highest 'poor' quality among removable appliances in the current study. This may be due to its more complicated design and construction. Al-Adwadhi et al. (2006)[1] similarly reported that about half of the functional appliances supplied to the orthodontic unit in St.James Hospital in Dublin were ill-fitting and one in five of them were considered unsatisfactory. There was no published literature on the retentive force of Adam's clasp in orthodontic appliances and the nearest comparison of metal clasps was the study by Takahasi et al[4]. They found no significant difference in the retentive force of wire and cast clasps in removable partial dentures. Instead both types of clasp showed a large variation in the retentive force among the technicians due to individual technical skills.

Adherence to design specification was highest in plastic retainers, followed by FA, acrylic retainers, URA, TPA and quadhelix respectively. There is minimal design for plastic retainers other than the peripheral edges, thus it was obvious that it had the highest rating. In contrast, quadhelix is more complicated and requires more precise wirework and positioning. Unclear or inadequate written and pictorial instructions by orthodontists may be a possible factor although this was not evaluated in this study. Although there was no published literature on the level of written communication between orthodontist and laboratory technician, the study by Leith et al. (2000)[5] showed that the written prescriptions for anterior ceramic prostheses between dentist and technician was inadequate. They reported that many technicians had to clarify instructions with the prescribing dentist by telephone or forced to make decisions without the necessary information. They concluded that 'time pressure' was the single greatest impediment to a harmonious working relationship and recommended improving levels of communication between these two parties.

The overall percentage of 'poor' quality rating from the current study was less than 4%, which was less than the reported 10% of unsatisfactory work in the study by Al-Adwadhi et al. (2006)[1]. Quality in fixed appliances especially quadhelix was not as high as removable appliances probably due to the more challenging soldering technique and wire-bending. This is more evident when done in less experienced hands of trainees. Heidemann et al. (2002)[6] found that the prevailing joining technique using silver soldering was prone to incomplete filling of the gap, porosities and corrosion and there were variations in quality among the technicians. Vahed et al. (2007)[7] recommended that the tensile strength of soldered orthodontic joints not be compromised by poor technique as corrosion is inevitable with silver solders. Alternative joining techniques such as laser welding may be considered in the future.[4]

There was large disparity in work output from individual technicians within and between centres. But workload did not appear to be directly associated with quality as technicians with lighter workload did not have higher percentage of 'good' quality appliances compared with those with heavier workload.

CONCLUSION

The quality of removable orthodontic appliances in Selangor was generally high with mean 'good' quality of 84.2% in all aspects and 'poor' quality in 2.3% of patients. Quality was lower in the quality of soldering (72.3%) in fixed appliances. Shah Alam had consistently lowest 'good' quality rating in all

aspects (13.6%) compared with other centres (>88%). Junior technicians had marginally higher percentage of 'good' quality rating than senior technicians but work output was less than half of senior technicians. Trainees scored lower 'good' quality rating in all aspects and there was large disparity in individual output from technicians within and between centres.

RECOMMENDATION

Managers should set minimum output targets for each technician for more equitable distribution of workload so that some are not over-burdened. Trainees and technicians with less previous exposure to orthodontic work need more in-house training and guidance from orthodontists for better quality of work. Routine monitoring of appliance quality by orthodontists is a useful exercise for constructive criticism and positive affirmative action for continued improvement of technicians' work.

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