Quality of Lab Appliances in Orthodontic Offices

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Lab appliances are an integral part of orthodontics, from active treatment to retention. The quality and fit of an appliance can affect the treatment result and stability. AIMS: This study aims to determine common points of failure in orthodontic appliances, and suggest methods to reduce this rate. METHODS: A survey consisting of 23 questions was distributed to active members of the American Association of Orthodontists (AAO) via Survey Monkey. RESULTS: The most common appliance to need an adjustment was the wrap-around retainer, with the Hawley retainer as a close second. The least common appliance needing adjustment was the Essix/clear retainer. Respondents were asked which component of each appliance was most commonly responsible for an ill-fit. For Hawley and wrap-around retainers, clasps were the most common problem at 50%, whereas spring aligners had two components - clasps and labial bows, both at 38%. Ill-fitting Essix/clear retainers had gingival impingement (52%) closely followed by poor posterior seating (43%). CONCLUSIONS: Communication between the orthodontist and lab technician can be improved by establishing a quality assurance protocol for outgoing and incoming cases. The labial bow of Hawley's, wrap-arounds and spring aligners should be clearly demarcated on the casts. Impressions should be free of distortion and casts should be inspected for accuracy. Clear retainers and positioner should be trimmed to avoid gingival impingement. The type of clasp should be selected based on the anatomy of the teeth, and bands should be checked for accuracy of fit.

Key words: Laboratory appliances, failures,

INTRODUCTION

Lab appliances are an integral part of orthodontics, from active treatment to retention. The quality and fit of an appliance can affect the treatment result and stability. Many practitioners have protocols in place based on personal preferences. Appliances can be fabricated chairside, via in-house lab or sent to orthodontic labs all across the country. The communication between an orthodontist and lab technician is of utmost importance.

There are several studies reporting survival times and failure trends of laboratory-made space maintainers,[1,2] but there is little information about specific orthodontic appliances. This study aims to determine common points of failure in orthodontic appliances, and suggest methods to reduce this rate.

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MATERIALS AND METHOD

A survey consisting of 23 questions was distributed to active members of the American Association of Orthodontists (AAO) using their Partners in Research program. The AAO consists of 8 constituent groups throughout the United States and Canada, with over 17,000 member orthodontists. The Partners in Research program selects a percentage of randomized active members to receive the survey via Survey Monkey. The questions covered quality assurance protocols, failure rate of orthodontic appliances and reasons for failure of each appliance. The study was approved by the institutional review board of A.T. Still University and administered via Survey Monkey.

The questionnaire was e-mailed to 2,298 randomly selected AAO members. Follow up e-mails were distributed two additional times to non-respondents. No compensation or other incentives were offered for completing the survey, which was to be done anonymously. A total of 137 responses were received for a 6% response rate.

RESULTS

Only 20% of respondents reported using an in-house lab only. The majority of orthodontists (53%) reported using both in-house and outside laboratories, with Essix/clear retainers being the most commonly fabricated in-house appliance.

67% reported that impressions are poured before being sent to the lab, with 78% using standard alginate material. Interestingly,

digital scans (60%) were ranked higher than PVS material (55.3%) as being the respondents second most common impression type.

75% of orthodontists check the case for quality assurance before it is sent out to the lab (Figure 1). Quality assurance most commonly consists of ensuring bands are seated, checking lab slip prescriptions for accuracy and sketching the appliance design on the model or lab slip (Figure 2). When bands are required, 75% of respondents fit them in the office and 64% send the stone model to the lab with bands in place.

75% of orthodontists also check quality assurance of lab cases being returned, with visual inspection being the most common procedure at 89% (Figure 3). When asked to estimate the percentage of appliances that fit correctly on the first try, answers ranged from 10-100%, with the most common answer being 95%. The most common appliance to need an adjustment was the wrap-around retainer, with the Hawley retainer as a close second. The least common appliance needing adjustment was the Essix/clear retainer.

Respondents were asked which component of each appliance was most commonly responsible for an ill-fit (Table 1). For Hawley and wrap-around retainers, clasps were the most common problem at 50%, whereas spring aligners had a close tie for labial bows (39%) and clasps (38%). Ill-fitting Essix/clear retainers had gingival impingement (52%) closely followed by poor posterior seating (43%). Bands were an issue in 59% of RPE cases, 48% of space maintainer cases and 60% of fixed functional cases (i.e. Herbst, MARA). For positioners, 44% cited the trim of the material as the most ill-fitting component. In removable functional appliances (i.e. Bionator, Twin Block), the acrylic ramp was cited at 32%.

When asked how many appliances fail or break within the first six months, 5% was the most common estimate, with a range of answers from 0-25%. The three most common areas of failure or breakage were cement loss at bands, broken or split bands and eruption interference. This is consistent with Fathian *et al*,[1] where 60% of space maintainer failures were attributed to cement loss.

Figure 1. Quality assurance. Percentage of lab cases checked, and by whom.

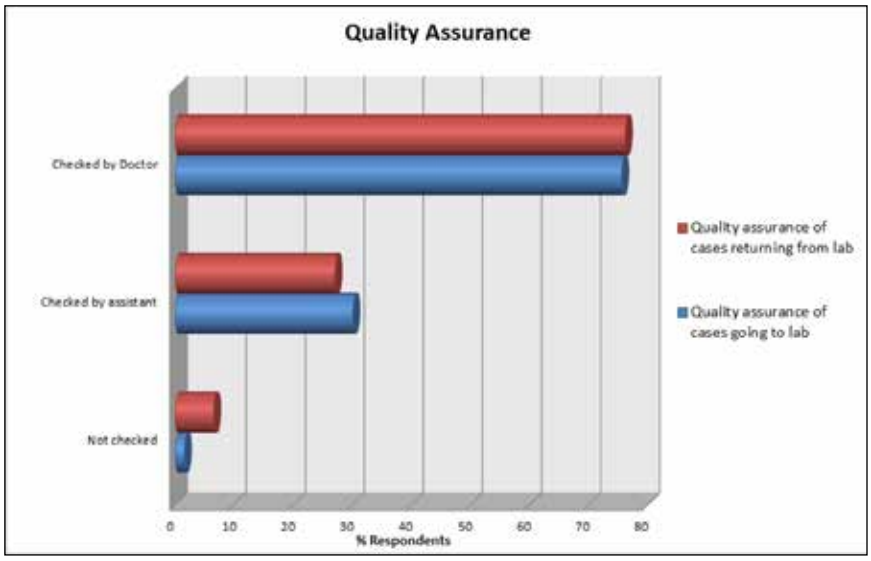


Figure 2. Quality assurance of outgoing lab cases. The most common features checked on cases being sent to an outside lab, listed from most to least common.

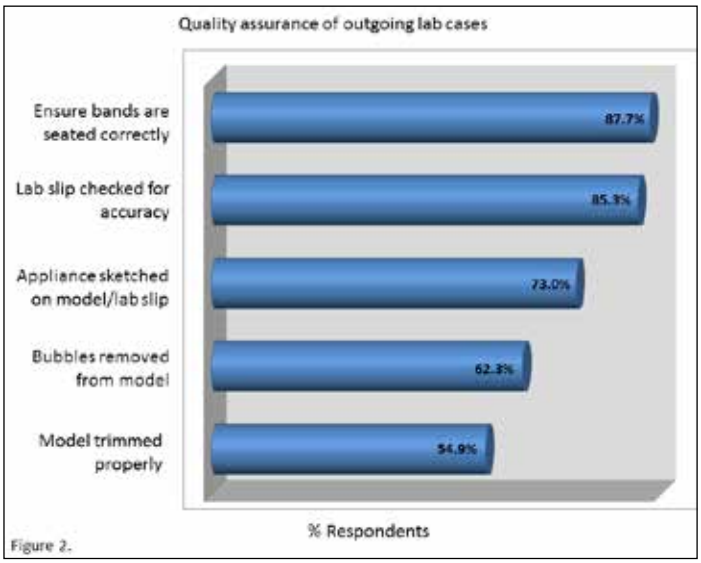
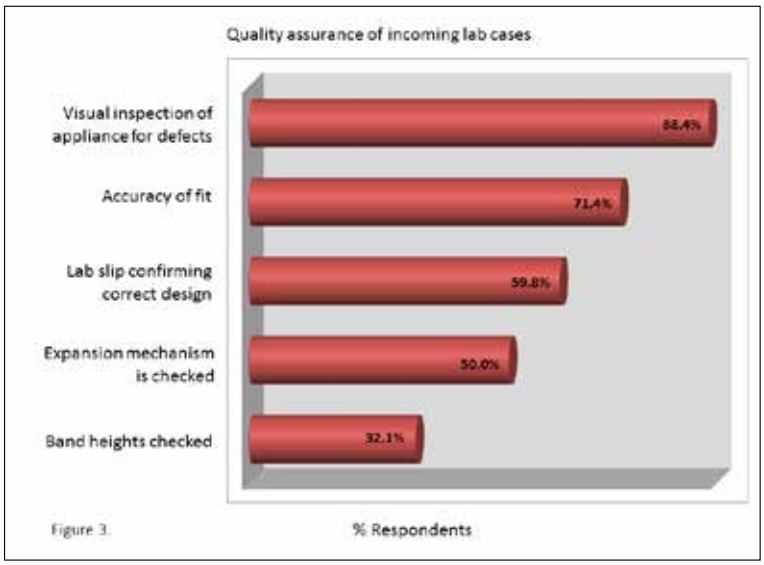


Table 1. Component most responsible for ill-fitting appliance

Appliance	Component	% Response
Hawley retainer	Clasps	50.5
Essix	Gingival impingement	51.6
Spring aligner	Labial bow	38.6
RPE	Bands	59.2
Space maintainer	Bands	49.4
Positioner	Trim of material near gingival margin	43.6
Fixed functional appliance	Bands/Crowns	59.2
Removable functional appliance	Acrylic guides	31.1

Figure 3. Quality assurance of incoming lab cases. The most common features checked on cases returned from an outside lab, listed from most to least common.



DISCUSSION

Identifying common areas of failure in orthodontic appliances is the first step in efficient communication between the orthodontist and lab technician. Inconsistent quality assurance leads to ill-fitting appliances and misplaced blame. Discussion of what defines a well-fitting appliance and which parts of the appliance are more susceptible to failure will improve overall quality. An open dialogue from both sides will ensure that the lab is receiving the highest quality models and, in turn, the orthodontist will receive high quality appliances.

A quality assurance (QA) evaluation of incoming and outgoing lab cases will guarantee consistency and continuity between the office and lab technician (Figure 4). The sample form shown here includes the most common errors when sending impressions and receiving appliances. This form can be modified to meet the needs of any practice and will ensure that the staff is well trained in their techniques for appliance fabrication. Importantly, it must be a collaborative effort between both parties so that all conditions are met.

With the advent of more accessible 3-dimensional technologies, many offices are moving towards digital models. An increasing number of labs will accept these digital files and create a cast for appliance fabrication. The relationship between the orthodontist and lab technician will continue to evolve as these technologies are developed. Distortion of alginate impressions, inaccurate pour up of bands and damage to plaster casts are no longer obstacles with digital models. While efficient quality control continues to be important, the protocols put in place may differ depending on the type of model being submitted (i.e. plaster vs. digital). Several studies have determined that the accuracy of laser-scanned models is similar to both plaster and CBCT models.[3-5] Kim et al[6] showed that models fabricated from intraoral scans have comparable accuracy to models fabricated from conventional impressions. However, there have been no studies that we are aware of which compare the fit of appliances made with alginate impressions vs. digital scans. Although the accuracy of model fabrication is "comparable", this term needs to be defined very accurately. A text by Choi and Jeong[7] demonstrated a 0.77 mm difference in intermolar width between a traditional model and a model fabricated from an iTero scan. This insignificant accuracy may indeed be significant enough to affect the fit of an appliance. Further studies are needed to determine the accuracy of not only models, but appliances fabricated from digitally rendered casts.

A limitation of this study is that it did not address office vs. lab error, or how these errors are corrected. It can be difficult to determine if the ill-fitting appliance was caused by the impression or fabrication. A small inaccuracy in each step may contribute to the overall failure of the appliance. If an appliance needs to be remade, the office and lab should have a clear agreement in place as to what qualifies for a refund. These questions require further study on both ends to determine the criteria.

Additional limitations of this study include the response rate and selection bias. 137 out of 2,298 responses were collected from the AAO member database. Many e-mails kicked back an automatic response, indicating that it was a practice related e-mail address and may not have been monitored by the orthodontist. Offices utilizing in-house laboratories and digital offices may not have responded, assuming the survey would not apply to their offices. Other offices may be transitioning from plaster to digital models, so the protocols in place are no longer optimal.

Based on the results of this survey, communication between the orthodontist and lab technician can be improved by establishing a quality assurance protocol for outgoing and incoming cases. Both the office and lab should contribute to the QA form to insure the quality of the appliances.

In terms of specific appliances, the labial bow of Hawley's, wrap-arounds and spring aligners should be clearly demarcated on the casts. Impressions should be free of distortion and casts should be inspected for accuracy. Clear retainers and positioner should be trimmed to avoid gingival impingement. Posterior areas of casts

Figure 4. Quality assurance form. Example of a quality assurance form that can be used to evaluate lab cases. This can be used by both offices and laboratories.

OUTGOING LAB CASE QUALITY ASSURANCE SLIP

Patient name: Appliance:

Checked by: Date:

IMPRESSIONS	Yes	No	N/A
Detailed gingival margin and dental anatomy			
Accurate soft tissue anatomy			
No distortion			
No large voids			
Palatal anatomy accurate			
No tray separation			
Properly disinfected and bagged			

APPLIANCE MODELS			
No voids or bubbles			
Detailed dental anatomy			
Accurate soft tissue anatomy			
Bands are positioned properly			
Proper trim			
Occlusion verified			
Appliance drawn on model/Rx			

PRESCRIPTION			
Lab Rx checked for accuracy			

INCOMING LAB CASE QUALITY ASSURANCE SLIP

Patient name: Appliance:

Checked by: Date:

APPLIANCE	Yes	No	N/A
Lab slip referenced to confirm correct design			
Expansion mechanism checked			
Visual inspection for defects			
Proper fit/contour of clasps			
Trim of material to avoid gingival impingement			
Labial bow contacts all teeth at the proper height			
Band/crown height and fit accuracy			
Acrylic guide/ramp appropriate design			

should be inspected for accuracy. The type of clasp should be selected based on the anatomy of the teeth, and these teeth should be free of bubbles or distortion. Bands should be checked for accuracy of fit, and should be inspected for distortion after removal.

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