In This Issue:

Letter from the Editor - David C. Sarrett, DMD, MS

Happy New Year.

This issue begins the ninth year for the ADA Professional Product Review. Over the years, the publication has featured evaluations ranging from intraoral cameras and curing lights to restorative materials and digital impression systems. We’ve also examined a variety of handpieces, a staple of most dental practices, and for this issue, the ADA Laboratory purchased and tested the Midwest Stylus ATC 890 (DENTSPLY Professional), a “hybrid” high-speed air-turbine handpiece that integrates elements drawn from both air-turbine and electric handpieces.

This issue also features the results from a handpiece collaboration with dentists at the U.S. Department of Veterans Affairs and at several U.S. military installations. The participants provided their clinical impressions of two disposable handpieces—the Azenic DHP (Azenic, Inc.) and the GSYO3D (NPH USA, Inc.), both of which the ADA Laboratory evaluated last year (See Volume 8, Issue 2). The purpose of the collaboration was to determine if practitioners thought the two products performed as well as conventional handpieces.

Lastly, we present “An Evaluation of Disposable Dental Patient Napkin Holders and Napkins.” As you’re well aware, most dental procedures involve exposure to saliva and blood that may be contaminated with pathogenic organisms and easily spread by direct and indirect contamination to operatory surfaces and equipment. This study examined three disposable napkin holders and three disposable patient napkins that do not require a reusable holder.

We have a lot more planned for 2014 and beyond. Is there a product or product category you would like to see evaluated? Contact me at ppeditor@ada.org. In the meantime, all the best to you, your families and staff in 2014.
A Laboratory Evaluation of the Midwest Stylus ATC 890 Dental Handpiece

The high-speed air-turbine handpiece is standard equipment in modern dentistry. In recent years, an increasing variety of handpieces with diverse capabilities, intended applications, and performance claims has produced a need for continued, in-depth testing, analysis and product comparisons. The introduction of models ranging from single-use disposable handpieces (see ADA Professional Product Review, Volume 8, Issue 2) to those with novel designs poses unique challenges for the evaluation of their clinical utility.

For this evaluation, the ADA Laboratories purchased the Midwest Stylus ATC 890 (DENTSPLY Professional, Des Plaines, IL), a “hybrid” high-speed air-turbine handpiece that incorporates elements drawn from both air-turbine and electric handpieces. In particular, the Midwest Stylus ATC 890 includes a control system that regulates the air pressure delivered to the handpiece (Figure 1).

Although the Midwest Stylus ATC 890 is an air-turbine handpiece, the principle behind its operation is similar to the way an electric handpiece functions: it uses a control system that works to keep rotational speed constant despite changes in resistance to cutting as a result of increased load. As illustrated in Figure 1, the control system of the Midwest Stylus ATC 890 forms a feedback loop that checks estimated speed from a sensor in the handpiece against a target range, and adjusts air pressure to the handpiece whenever the speed deviates from that range, whether free-running or under load while cutting. The major goal of this evaluation was to characterize the performance of the Midwest Stylus ATC 890 control system to determine how it might behave in clinical practice.

Materials and Methods

When evaluating a handpiece such as the Midwest Stylus ATC 890, measuring its performance under a variety of conditions is necessary to characterize the clinically relevant features of the design. This product, however, is not a stand-alone handpiece, but an integrated system meant to be installed in a chairside dental unit. The ADA Laboratories designed and built a special system to test

Figure 1. Midwest Stylus ATC 890 Control Feedback Loop. The control system forms a feedback loop that checks estimated speed from a sensor in the handpiece against a target range, and adjusts air pressure to the handpiece whenever the speed deviates from that range.
Continued from previous page

the torque, speed, power, and air usage of conventional air-turbine handpieces, which was adapted for the evaluation of the Midwest Stylus ATC 890. Figure 2 shows a diagram of the modified test system, including all the parameters recorded during testing.

In addition to the Midwest Stylus ATC 890, the ADA Laboratories tested a conventional air-turbine handpiece for comparison (Solara QT, DentalEZ, Malvern, PA). This data is intended to help dentists better understand how the behavior of the Midwest Stylus ATC 890 differs from a typical air-turbine handpiece in some respects, while it is the same or similar for other performance parameters. In cases where the behavior of the Midwest Stylus ATC 890 can be compared to an electric handpiece, theoretical data for an electric handpiece is also provided. (For complete evaluations of high-speed air-turbine handpieces, see ADA Professional Product Review, Volume 2, Issue 3 and Volume 8, Issue 2; refer to Volume 5, Issue 3 for an evaluation of electric handpieces.)

Results and Analysis

Torque and Speed

Torque ($\tau$), or the tendency of a force to rotate an object about an axis, is calculated as the product of the applied force ($F$) and the distance from the axis of rotation ($r$), $\tau = (F)(r)$. It is important to note that, since the distance from the axis of rotation ($r$) remains the same throughout this evaluation (radius of bur, i.e. test mandrel, remains constant), the measured torque is directly related to the applied force, which is referred to here as the "load" applied by the clinician. To quantify the ability of a handpiece to generate torque, laboratory engineers used a rope-brake system consisting of a test mandrel with a known radius and force sensors attached to a string looped around the test mandrel, as depicted in Figure 2. (For a complete discussion of the rope-brake system, refer to the evaluation of disposable high-speed air-turbine handpieces in the ADA Professional Product Review, Volume 8, Issue 2.)

Figure 2. Diagram of Handpiece Test Apparatus. The test apparatus used for conventional air-turbine handpieces required modifications to incorporate the Midwest Stylus ATC 890 control unit and to assure accurate measurement of supply air at all points of interest without significantly disrupting handpiece function. Computer controlled stages with mounted force sensors were used to pull a "rope-brake" tight around the spinning test mandrel, controlling the applied load while an optical sensor recorded the speed.
For a typical, conventional air-turbine handpiece, speed decreases as the resistance to rotation of the instrument in the handpiece increases. As illustrated in Figure 3, the trace corresponding to the conventional air-turbine handpiece shows that as torque increases, the speed decreases linearly from free-running speed to stall forming a linear relationship with a negative slope. However, the same trend is not observed for the Midwest Stylus ATC 890. Instead, as increasing applied load causes the measured torque to increase, an initial horizontal speed vs. torque relationship is observed in the high-speed region “A”, followed by a linear decreasing speed trend. This means there are two distinct phases of operation where the Midwest Stylus ATC 890 operates differently, depending on the load applied by the user.

During the first phase of operation, depicted by the horizontal region “A”, the control system of the Midwest Stylus ATC 890 works to maintain relatively constant speed at values near the free-running speed, despite increasing load. This behavior can be compared to the similar response of an electric handpiece, as depicted with a theoretical curve in Figure 3. As you apply greater load to an electric handpiece, the speed is maintained through the control system, producing a horizontal speed vs. torque relationship over clinically relevant applied load levels. The Midwest Stylus ATC 890 behaves much the same way during the first phase of operation, where changes in cutting load produce only small transient changes in speed, resulting in a smooth cutting experience even as the user applies a changing load. As the applied load continues to increase, however, there is a specific point where the speed begins to decrease and the second phase of operation is observed. At this point, termed the “transition point,” the Midwest Stylus ATC 890 begins to perform more like a conventional air-turbine handpiece with a linearly decreasing speed-torque curve.
Continued from previous page

Transition Point
The transition point marks a distinct split of the handpiece performance into two phases: one where speed is relatively constant despite increases in applied load, similar to an electric handpiece; and a second phase where speed decreases linearly with increases in applied load, similar to a conventional air-turbine handpiece. A thorough examination of the handpiece operation on either side of this unique transition point provides insight into the potential clinical performance of the Midwest Stylus ATC 890.

Figure 4 illustrates how the control system of the Midwest Stylus ATC 890 responds to increasing applied load. Specifically, at times when the handpiece speed (green curve) deviates from the “target range” of approximately 325,800 to 330,600 rpm (blue horizontal lines), the control system compensates by adjusting the air pressure, which is shown as discrete pressure “jumps” in the pressure vs. time plot (red curve). The control system delivers an increase in air pressure when the speed of the handpiece drops below the minimum target speed. The sudden increase in air pressure can cause the speed to overshoot the target speed range, which triggers an immediate reduction in pressure until the speed stabilizes in the target zone. As the applied load continues to increase, this cycle repeats creating the saw-tooth shaped curves: speed (green) and pressure (red). However, once the air pressure reaches the maximum threshold and cannot be increased further, the transition point (vertical purple lines) is reached. Beyond the transition point, in the second phase of operation, the speed of the Midwest Stylus ATC 890 begins to linearly decrease with increases in applied load, as one would expect for a conventional air-turbine handpiece.

Power
The power produced by a dental handpiece is calculated by multiplying the measured torque by the speed. The previously discussed speed–torque data are used to plot corresponding power curves. For typical air-turbine handpieces, a parabolic power vs. speed relationship is observed, as shown by the characteristic curve of the conventional air-turbine handpiece in Figure 5. Specifically, a typical air-turbine handpiece does not produce a maximum power output at the free-running speed or when too much force is applied (i.e., close to stalling when pressing into the tooth), but rather in the middle of the speed range.

Figure 4. Midwest Stylus ATC 890 Response to Increasing Applied Load. In region “A,” as applied load increases, speed and pressure curves display “saw-tooth” patterns with the average speed remaining constant, while the net air pressure steadily increases. The saw-tooth appearance is the result of the control system overshooting the target speed range and immediately adjusting air pressure to correct it. The vertical purple lines mark the transition, where the air pressure reaches its maximum and cannot be increased. Past this point, speed decreases linearly with increases in applied load.
This peak of the power curve is sometimes referred to as the “sweet spot,” and it occurs when the handpiece torque and speed are “balanced.” An experienced clinician intuitively “feels” and/or hears this sweet spot and adjusts the applied load accordingly. Technically, this occurs halfway between the free-running speed of the handpiece and when the handpiece stalls and drops to zero rpm.

Electric handpieces present an entirely different picture. As you apply a greater force to an electric handpiece, the device tries to maintain speed through its control system by drawing more power from the electric motor. In Figure 5, this behavior is illustrated by the theoretical power curve of an electric handpiece, where power increases at a relatively constant speed and a nearly vertical plot is generated.

Again, the “hybrid” nature of the Midwest Stylus ATC 890 presents a unique power vs. speed relationship, with two distinct regions corresponding to both electric handpiece-like and air-turbine handpiece-like modes of operation. In Figure 5, the electric handpiece-like operation is designated as region “A,” which corresponds to the same region “A” previously described in Figures 3 and 4. This now vertical region corresponds to the increasing power produced when the control system is increasing pressure to keep speed constant. At the transition point, the air pressure reaches a maximum threshold and the Midwest Stylus ATC 890 begins to audibly reduce speed as it deviates from the electric handpiece-like vertical region. As it continues to slow, the clinician “feels” and hears the “sweet spot” as torque and speed are balanced with a higher peak power than the conventional air-turbine handpiece. Comparing the red, blue, and green Midwest Stylus ATC 890 curves in Figure 5, note how the transition point and peak power can shift significantly by varying the threshold of compressed air delivered by the air supply system.

**Air Usage and Efficiency**
Based on data collected continuously from the supply air throughout the testing, the air usage characteristics of the Midwest Stylus ATC 890 were determined and compared with a typical conventional air-turbine handpiece (Table 1).
The Midwest Stylus ATC 890 does not have set air usage values when it is operating in the constant speed region, as pressure is constantly being adjusted by the control system. This produces extremely high pressure at the handpiece, as indicated in Table 1. The high pressure combined with the high mass flow rate means that this handpiece can consume large amounts of compressed air power.

The efficiency index is the ratio of the measured power to the maximum theoretical power that could be extracted from the air, based on air pressure, flow rate, and temperature. While the Midwest Stylus ATC 890 can produce more power than conventional air–turbine handpieces, the efficiency index is relatively low due to the high air consumption rate (Table 1).

Based on this information, it appears that the high power and dual electric/air–turbine behavior of the Midwest Stylus ATC 890 may come at the cost of reduced measures of efficiency and high air consumption when the device is fully engaged.

### Installation Notes

The evaluation of the Midwest Stylus ATC 890 revealed the critical importance of proper installation and maintenance for this handpiece system. The system is more complex than conventional air–turbine handpiece systems, as the peak power and the transition point depend heavily on maximizing air flow. Additionally, poor tubing configurations can contribute to unwanted oscillations and poor response time. Although we found the manufacturer’s instructions and technical assistance satisfactory, this is not a “plug-and-play” type of device. We recommend installation by a trained professional to assure the best performance from this complex and somewhat sensitive system.

### Conclusions

The control system of the Midwest Stylus ATC 890 is effective at maintaining speed within the target range when the applied load is low to moderate (i.e., at powers up to about 13 Watts). In this region, the Midwest Stylus ATC 890 operates similarly to an electric handpiece. That is, changes in cutting force produce only small transient changes in speed, resulting in a relatively smooth cutting experience even as the user applies a changing load.

At a specific transition point, the control system of the Midwest Stylus ATC 890 reaches maximum air pressure, and additional increases in load produce decreases in speed in a manner characteristic of conventional air–turbine handpieces.

This transition between the electric handpiece–like and air–turbine handpiece–like regions of the Midwest Stylus ATC 890 may offer some additional utility in clinical use. For example, when the user is continuously applying load, the audible switch from a stable constant speed to decreasing speed, can serve as an indication that the handpiece is nearing peak power, while the application of a significantly increased load may be counterproductive and could lead to stall.

Finally, an additional factor that emerged from our testing is the importance of a properly installed system that is appropriately maintained. During testing, it was shown that poor tubing configurations appeared to contribute to unwanted oscillations and poor response times. To get the best performance out of this system, we recommend installation by a trained professional.

### Table 1. Measures of Compressed Air Usage and Efficiency.

<table>
<thead>
<tr>
<th>Handpiece</th>
<th>Pressure at Chairside Equivalent [psi]</th>
<th>Pressure at Handpiece [psi]</th>
<th>Mean Efficiency Index at Peak Power ± standard error [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midwest Stylus ATC 890</td>
<td>61.6</td>
<td>58.4</td>
<td>21.7 ± 0.3</td>
</tr>
<tr>
<td>Conventional Air-Turbine</td>
<td>37.7</td>
<td>34.0</td>
<td>24.3 ± 0.4</td>
</tr>
</tbody>
</table>

The pressures shown here were used for all testing and represent pressures set at the equivalent of a chairside dental unit and measured at the handpiece inlet. For the Midwest Stylus ATC 890, the pressure was set while the handpiece was stalled, upstream of the control box to meet the minimum requirements of 70 psi and 56.6 standard liters per minute. The pressure delivered by the control system was variable and, thus, was measured at the exit of the box (chairside equivalent) and at the handpiece. Values for the Midwest Stylus ATC 890 depend on available compressed air, so these values represent estimates of minimum performance. The conventional air–turbine handpiece was tested at the manufacturer’s recommended pressure. Efficiency was calculated by dividing peak power by the maximum theoretical power delivered in the compressed air (based on the associated pressure, flow rate, and temperature data for that point).

### References

The purpose of this study was to clinically evaluate three disposable napkin holders and three disposable patient napkins not requiring a re-usable napkin holder.

**Background:** Most dental procedures involve exposure to saliva and blood that may be contaminated with pathogenic organisms and easily spread via direct and indirect contamination to dental operatory surfaces and equipment.¹ To reduce the time and cost involved with cleaning and sterilizing reusable items, practitioners often use disposable products during patient care. When performing dental procedures of all types, the standard of care is to place a cloth or paper napkin cover on the patient to protect skin and clothing from aerosols and spatter generated during the procedure. Dental patient napkins used during routine dental procedures are most often disposable but napkin holders typically are reusable chains or flexible tubing (coiled or non-coiled) with alligator clips or some other mechanism for attachment to the disposable patient napkin. The reusable napkin holders are likely to contact the patient’s skin and may be contaminated with saliva and/or blood from direct contact with the operator’s gloved hands or from spatter and aerosol created during the dental procedure. If not properly cleaned and disinfected or sterilized, the contaminated napkin holders may expose patients or staff to bacteria or viruses via direct contact. One recently published study of two different types of bib clips used in the endodontic and orthodontic clinics at a dental school revealed that, while disinfection by wiping with an intermediate level disinfectant was highly effective, 20 to 30 percent of both types of bib clips harbored bacteria following disinfection.²

According to CDC guidelines¹, since reusable napkin holders contact “intact” skin they are considered non-critical patient care items.

The CDC guidelines state: “Noncritical patient-care items pose the least risk of transmission of infection, contacting only intact skin, which can serve as an effective barrier to microorganisms. In the majority of cases, cleaning, or if visibly soiled, cleaning followed by disinfection with an EPA-registered hospital disinfectant is adequate. When the item is visibly contaminated with blood or OPIM [other potentially infectious materials], an EPA-registered hospital disinfectant with a tuberculocidal claim (i.e., intermediate-level disinfectant) should be used.”

Various types of disposable dental patient napkins and patient napkin holders are currently available to the dental profession. Practitioners need to make informed decisions on whether to use disposable or reusable products for patient protection in their practices.

**Methods and Materials:** Following Institutional Review Board (IRB) approval for the evaluation, 10 clinical practitioners from various clinics at Virginia Commonwealth University (VCU) School of Dentistry in Richmond, Virginia, were selected to evaluate the clinical effectiveness of three disposable dental patient napkins and three disposable napkin holders. The evaluators were volunteers and consisted of dental assistants or dental hygienists and the evaluations were all performed during various patient care activities at the VCU School of Dentistry. Prior to beginning the evaluation, each evaluator completed a survey on their previous level of experience using each of the six disposable products, as well as reusable patient napkin holders requiring disinfection and/or sterilization between patients.

The primary aim of the study was to rate product performance and practitioner satisfaction. An evaluation form was developed in collaboration with staff at the ADA Division of Science. In addition, each evaluator was given written instructions explaining how to properly answer the 16 questions on the evaluation form. Each survey captured the product being evaluated, the type of procedure(s) being performed and allowed for a rating of each product based on seven criteria.

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including ease of use, moisture protection, coverage and retention, and overall satisfaction. The rating section used a Likert scale of excellent, good, poor or not applicable. The survey form included questions about product failure as well as other problems encountered during use and the type of procedure(s) during which the problems or failure occurred.

Evaluators were briefed on the evaluation process and use of the evaluation form prior to beginning the clinical evaluations. After using each product on a target of 10 patients, the evaluator completed the evaluation form for that product. Evaluators were instructed to keep their evaluations independent of one another and use the products in random order. To accommodate for damage or need to replace items during the evaluation, evaluators were provided extra products.

The three disposable patient napkins evaluated included: one with adhesive tabs on the top two corners of the napkin (Sani-Tab chain-free towel, Crosstex Intl.); one that has paper ties as part of the napkin (Chainless Bib with ties, TIDI Products); and one that pulls over the patient’s head (Fabricel Slipover Bib, TIDI Products). The three disposable patient napkin holders evaluated included: two made of paper that could be stretched to vary the length and had adhesive tabs on each end to attach to the patient napkin (BIB-EZE paper napkin holder, DUX Dental) and (ProBarrier disposa chain, Certol Intl.); and one made of plastic with molded clips on each end to secure the patient napkin (SNAP-Its disposable plastic bib holder, DUX Dental).

**Results:** Eight of the 10 evaluators completed their evaluations on all six products. The remaining two evaluated three or fewer products and were excluded from the analysis. Seven of the evaluators reported that 10 patients were observed for each of the six products evaluated. Because of a part-time work schedule, one evaluator reported using six patients for Bib-Eze, eight patients for the Snap-Its products, and 10 patients for the four remaining products.

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**Behind the Scenes:**

**Touring the ADA Laboratory**

The ADA Laboratory is housed in the Division of Science and includes dentists, dental materials specialists, microbiologists, chemists and engineers and a machine shop. Together this group develops and conducts tests and, when necessary, designs the equipment needed to adequately evaluate products, which includes professional products used by dentists and some products in the ADA Seal of Acceptance Program. The Laboratory also designs and applies new tests for the development and revision of standards and conducts research studies on critical and emerging issues of importance to practicing dentists.

“I encourage members who visit Chicago to stop by the ADA Headquarters and visit the laboratory to learn more about their research capabilities.”

—Dr. David Sarrett, the Review’s editor.

To arrange a tour of the ADA, contact Ms. Bridget Baxter at the ADA’s toll-free number at 800-621-8099, ext. 2397.

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The eight evaluators completed a questionnaire about their prior experience with the six products being evaluated and responses are outlined in Figure 1. All of the evaluators indicated that they had never used the Fabricel Slipover napkin, the Sani-Tab napkins or the Snap-Its napkin holder. Six evaluators had experience with one or more of the other disposable products.

Most of the evaluations (75 percent) were performed during cleaning/prophy (including scaling and ultrasonic scaling) appointments; however, the other evaluations took place while a variety of treatments were performed. Endodontic treatment was performed in 6 percent of the evaluation periods. Periodontal treatment was performed during 12 percent of the evaluation periods. Restorations were performed during 50 percent of the evaluation periods. Other treatments (examinations, oral surgery) were performed 12 percent of the time. There was no relationship between the treatments performed and the randomly assigned product being evaluated (chi-square P > 0.4). On only two occasions did a product need to be replaced due to performance failure: the Sani-Tab napkin during a restorative procedure and the ProBarrier napkin holder during a prophylaxis procedure.

The rating of each attribute for each applicable product is shown in Figure 2. The green bars indicate excellent performance, gray bars indicate good performance and red bars indicate poor performance. Repeated-measures ANOVA indicated no difference between products on ease of application (P > 0.13), but there was a significant difference between products on ease of removal (P < 0.001). Likewise, there was a difference between the napkins on covering the patient (P = 0.025), but there was no difference on adequate moisture protection of napkins (P > 0.2). There was a difference on napkins remaining in place (P = 0.025) but not on napkin holders remaining attached to patient napkins (P > 0.3). There was a significant difference on overall satisfaction with the products (P = 0.023).

Participants were asked to comment on any problems with product performance. The Fabricel Slipover (napkin) and SNAP-Its (napkin holder) received the most comments. A representative quote from evaluators about Fabricel: “Placement of the slipover bib is sometimes awkward because it brushes against the patient’s face and hair as it is put on. However, once placed, the napkin provides excellent coverage and remains in position.”
A representative quote from evaluators about SNAP-Its: “The plastic snap is difficult to close and impossible to reopen for adjusting placement. Also, the strap is hard and short, which negatively impacts comfort for some patients.”

The final question for each product evaluation asked, “Would you prefer using this disposable product to a conventional, reusable product which requires disinfection or sterilization?” In no case did more than half the evaluators prefer the disposable product (See Figure 3).

Figure 2. Product performance
Note: Napkins only were reviewed for patient coverage, moisture protection, and staying in place. Napkin holders only were evaluated for remaining attached to patient napkin.
Conclusions

Although there was no significant difference between the products on ease of application, there was a difference on ease of removal. All but one evaluator rated the BIB-EZE and Chainless Bib as excellent. The performance of the SNAP-Its was rated poor by 3 of 8 participants. For the napkins, the Sani-Tab had the highest percentage of negative ratings for patient coverage and for the napkin remaining in place. No significant difference in terms of moisture protection was evident. Similarly, when considering napkin holders, there was no significant difference among the products’ ability to remain attached. The BIB-EZE product was rated as excellent in all criteria by 60 percent or more of the participants. The SNAP-Its product was rated as excellent less than 20 percent of the time in all areas except remaining attached to the patient napkin. The overall product satisfaction of the napkin holders was highest with BIB-EZE and ProBarrier while SNAP-Its was lowest. The majority of evaluators did not have previous experience using the disposable products evaluated, and 5 out of 8 of them had used reusable napkin holders extensively. At the conclusion of the evaluation most evaluators indicated a preference for using a conventional reusable product over a disposable with the exception of the Chainless Bib with ties, which was preferred by four of the participants over reusable products. Despite preferring reusable products, evaluators rated the disposables’ ease of use, protection factor and overall satisfaction favorably based on the criteria.

The authors reported no disclosures.

References

Clinical Impressions of Two Disposable High-Speed Handpieces

Pre-sterilized disposable high-speed air-driven handpieces have recently entered the U.S. dental equipment market. These devices may be useful in clinical settings and situations involving unusual operating conditions or challenging infection control situations in which sterilization is not practical or cost-effective. Examples of such conditions include remote or mobile clinics, medical missions or military field installations, or perhaps in a busy practice as a backup if a sterile reusable handpiece is unavailable. Following the ADA Laboratory evaluation of two disposable handpieces (ADA Professional Product Review, Volume 8, Issue 2), this article presents dentists’ clinical impressions of these products. The ADA Laboratory purchased the Azenic DHP from Azenic, Inc., (Kalamazoo, MI) and the Hi-Speed Turbine Handpiece for Single Use-GSY03D from NPH USA, Inc. (Orlando, FL) for evaluation by dentists at the U.S. Department of Veterans Affairs and by dentists at several U.S. military installations. The purpose of this study was to determine if the FDA-approved and commercially available disposable high-speed handpieces perform as well as a conventional reusable high-speed air-turbine and/or electric handpiece. In this subjective evaluation, dentists examined whether the handpieces were in working order at both the beginning and the end of a procedure and whether the devices exhibited performance degradation during the procedure. The dentists’ clinical impressions of how the devices performed provide insight about the practical use of these products.

Background and Methods

The ADA Laboratory purchased and provided the Azenic DHP and NPH GSY03D disposable handpieces to dentist participants at 11 locations including the U.S. Department of Veterans Affairs, the U.S. Air Force and U.S. Army. Following Institutional Review Board (IRB) approval for the evaluation, the products were delivered pre-sterilized in individually sealed packages ready for clinical use and labeled with an expiration date. (For a complete list of product features, including cost, please refer to the ADA Professional Product Review, Volume 8, Issue 2.) Dentists were instructed to use the products as they would normally use conventional reusable handpieces, and then to complete a detailed questionnaire that focused on product performance. A total of 75 Azenic DHP and 105 NPH GSY03D handpieces were individually evaluated by 44 participants. Questionnaire responses were analyzed using Chi-square tests (SAS, version 9.3, SAS Institute, Cary, North Carolina) with a confidence level of 0.05 to denote statistical significance. The number of responses to specific questions varies slightly as some evaluators chose not to answer certain questions, or parts of a question. However, no systematic bias was introduced as incomplete questionnaires were collected at each site and the corresponding questions do not represent a pattern.

![Professional Experience of Evaluators](image)

Figure 1. Professional experience of evaluators.

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The vast majority of the evaluators (42 of 44) practice general dentistry, while one evaluator practices endodontics and the other practices prosthodontics. Slightly more than half the evaluators (54.6 percent) were in practice for five years or less at the time of the evaluation (Figure 1).

Participating dentists provided responses to the questionnaire about the type of handpiece they typically use (air-turbine or electric) for a given procedure. The disposable handpieces were used to perform a variety of procedures, most often for restoration and crown preparations (Figure 2). The disposable devices were not used to remove metal or all-ceramic crowns. Furthermore, when using the disposable handpieces, evaluators used carbide burs more often than diamond cutting instruments for both cutting (75.4 percent carbide) and finishing (68.8 percent carbide).

The type of procedure was reported for 67 of the 75 Azenic DHP evaluations and 97 of the 105 NPH GSY03D evaluations. For the majority of evaluations (80.8 percent), the disposable handpieces were used for 30 minutes or less over the duration of a single procedure. On average, each handpiece was operated for 10 to 20 minutes. The length of time a handpiece was operated varied significantly by treatment type, but not by handpiece brand.

Azenic Inc. claims the Azenic DHP will last a minimum of 16 continuous minutes in operation. In addition, the manufacturer states that the Azenic DHP is designed to allow for up to four bur changes, or a total of five burs, during use on one patient during a single appointment. NPH USA, Inc. claims the GSY03D disposable handpiece model can be used for a maximum operating time of 3 to 4 hours, or for up to 100 bur changes. Based on the manufacturers’ recommendations, neither the Azenic DHP nor the NPH GSY03D handpieces were operated for a maximum amount of time.

**Disposable Handpiece Performance**

The evaluators were asked to complete a questionnaire regarding handpiece performance for each procedure they performed with a disposable handpiece. At the beginning of each procedure, 103 of the 105 (98.1 percent) NPH GSY03D handpieces and 70 of the 75 (93.3 percent) Azenic DHP handpieces were reported

![Procedures Performed with Disposable Handpieces](image-url)

Figure 2. Procedures performed with disposable handpieces.
to have operated properly. Based on their impressions throughout the procedure, the dentists rated each disposable handpiece on several performance attributes (Table 1). On average, the participants consistently rated the NPH GSY03D handpieces the same as or better than traditional reusable handpieces for each performance attribute. However, the performance attributes ratings for the Azenic DHP varied significantly. Although the vast majority of evaluators rated the Azenic DHP disposable handpieces worse than traditional reusable handpieces in terms of the product’s noise level, they rated it positively in terms of other attributes.

### Table 1. Performance Attribute Ratings of the NPH GSY 03D and Azenic DHP Disposable Handpieces.*

<table>
<thead>
<tr>
<th></th>
<th>NPH GSY 03D performance compared to a traditional handpiece (N=103-105)</th>
<th>Performance Attribute</th>
<th>Azenic DHP performance compared to a traditional handpiece (N=73-75)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Worse</td>
<td>Same</td>
<td>Better</td>
</tr>
<tr>
<td>30 (28.6%)</td>
<td>72 (68.6%)</td>
<td>3 (2.8%)</td>
<td>n/a</td>
</tr>
<tr>
<td>11 (10.5%)</td>
<td>66 (62.8%)</td>
<td>28 (26.7%)</td>
<td>Removing / changing burs</td>
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<tr>
<td>14 (13.3%)</td>
<td>77 (73.4%)</td>
<td>14 (13.3%)</td>
<td>Weight</td>
</tr>
<tr>
<td>9 (8.6%)</td>
<td>89 (84.8%)</td>
<td>7 (6.6%)</td>
<td>Balance</td>
</tr>
<tr>
<td>6 (5.8%)</td>
<td>87 (83.6%)</td>
<td>11 (10.6%)</td>
<td>Grip (slippage)</td>
</tr>
<tr>
<td>14 (13.4%)</td>
<td>82 (78.9%)</td>
<td>8 (7.7%)</td>
<td>Fits my hand (comfort)</td>
</tr>
<tr>
<td>23 (22.3%)</td>
<td>72 (69.9%)</td>
<td>8 (7.8%)</td>
<td>Access to operative site</td>
</tr>
<tr>
<td>6 (5.8%)</td>
<td>92 (88.4%)</td>
<td>6 (5.8%)</td>
<td>Visibility</td>
</tr>
<tr>
<td>13 (12.4%)</td>
<td>79 (75.2%)</td>
<td>13 (12.4%)</td>
<td>Precision of the cut</td>
</tr>
<tr>
<td>9 (8.6%)</td>
<td>85 (80.9%)</td>
<td>11 (10.5%)</td>
<td>Level of vibration</td>
</tr>
<tr>
<td>9 (8.7%)</td>
<td>82 (78.8%)</td>
<td>13 (12.5%)</td>
<td>Speed stability (rpm)</td>
</tr>
<tr>
<td>7 (6.7%)</td>
<td>82 (78.9%)</td>
<td>15 (14.4%)</td>
<td>Torque/power</td>
</tr>
<tr>
<td>1 (1.0%)</td>
<td>99 (95.2%)</td>
<td>4 (3.8%)</td>
<td>Cutting efficiency</td>
</tr>
<tr>
<td>15 (14.4%)</td>
<td>72 (69.2%)</td>
<td>17 (16.4%)</td>
<td>Heat generated</td>
</tr>
<tr>
<td>24 (23.1%)</td>
<td>68 (65.4%)</td>
<td>12 (11.5%)</td>
<td>Water spray</td>
</tr>
<tr>
<td>6 (5.8%)</td>
<td>90 (86.5%)</td>
<td>8 (7.7%)</td>
<td>Noise level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bur stops promptly</td>
</tr>
</tbody>
</table>

* Ratings were reported for 103-105 NPH GSY 03D and 73-75 Azenic DHP handpieces, depending on the performance attribute.

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**Figure 3. Handpiece degradation vs. length of procedure, P > 0.05.** Data correlations were possible for 73 of the 75 Azenic DHP and 103 of the 105 NPH GSY 03D evaluations.
attributes—including vibration and ease of removing or changing burs. In every performance aspect in which participants preferred conventional handpieces, they consistently rated the Azenic DHP handpieces more unfavorably than the NPH GSY03D handpieces. Finally, when asked if they experienced any problems during use of the disposable handpieces, 95.5 percent of the evaluators reported having problems with the Azenic DHP, while 25.0 percent indicated that they experienced problems with the NPH GSY03D handpiece.

Disposable Handpiece Degradation and Failure
The term “handpiece degradation” refers to a perceived decrease in performance by the end of the procedure compared with the beginning. On the basis of the evaluators’ responses on the questionnaires, a higher percentage (28.8 percent) of the Azenic DHP handpieces than of the NPH GSY03D devices (6.7 percent) degraded in performance. When correlated with the length of time the handpieces were used (Figure 3), a greater percentage of handpieces degraded as the length of a procedure increased. Furthermore, when comparing the two most commonly reported procedures, evaluators reported that both the Azenic DHP and NPH GSY03D disposable handpieces were more likely to degrade if used for crown preparations than for restoration preparations.

The term “handpiece failure” indicates that the disposable device was not in working order (that is, stalled or stopped running). Participants reported that 10.8 percent of the Azenic DHP handpieces failed at the beginning of the procedure, compared to just 0.9 percent of the NPH GSY03D handpieces. Participants reported the same trend during and at the end of the procedure, with a greater percentage of Azenic DHP handpieces failing relative to the NPH GSY03D devices.

Bottom Line
While 86.1 percent of the participating clinicians determined that the NPH GSY03D disposable handpieces could meet their clinical needs the same as or better than traditional reusable handpieces, only 20.0 percent of the evaluators made the same determination regarding the Azenic DHP handpiece.

Figure 4. Disposable handpiece failure
* Indicates P < 0.01. Depending on the question, data correlations were possible for 74–75 of the Azenic DHP evaluations and 104–105 NPH GSY03D evaluations.
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