Nd:YAG laser-assisted removal of instrument fragments

By Dr Georgi Tomov, Bulgaria

The Nd:YAG lasers tested in laboratory studies have been claimed to be able to successfully manage the removal of instrument fragments within root canals. This is done in four ways, all correlated to temperature effects:

1. Laser melts the dentine around the fragment and then Hedstrom files are used to bypass and retrieve the fragment.
2. Laser melts the entire fragment.
3. Laser energy melts the solder, connecting the fractured instrument with a brass tube charged with solder and placed at the exposed coronal end of the fragment.
4. Laser welds the fragment positioned within a metal hollow tube (e.g. Endo-Eze Tip, Ultradent Products, Figs. 1a & b).

The removal of a claimed minimum amount of root dentine1,2,4 can be attributed to the potential given to the use of Nd:YAG laser to distinguish dentine from obstructions by the difference in acoustics produced by the two materials. Ebihara et al. observed that some obstructions of the dental tubules were blocked with melted dentine after laser irradiation. Yu et al. found that the temperature rose by 17°C to 27°C, but argued that, since the initial temperature was lower than human body temperature, these results were irrelevant.1

The findings demonstrated that a pulsed Nd:YAG laser irradiation has the capability of removing broken files. The success rate reported by Yu et al. was 55 per cent. However, the thermal effects found after Nd:YAG irradiation in dry root canals were considerable (Figs. 1a-c). Thus, the focus now is on the outcomes of using a laser fibre inserted into a hollow tube (alone or in the presence of solder) both to avoid dental caries and to achieve welding between the separated file and metal tube.

Intraoral laser welding

The intraoral laser welding phenomenon is well researched.1 Even for metals that absorb well, such as steel, the laser light is initially reflected. A small percentage of the laser light is absorbed, heating the metal surface. The increased surface temperature increases the absorption of the laser power. This creates a snowball effect, in which the material is rapidly heated by the laser, leading to melting and the consequent formation of a weld. Hagiwara et al. performed laser welding on stainless steel or nickel-titanium files using an Nd:YAG laser in order to evaluate the retention force between the files and the metal extractor. Additionally, they evaluated the increase in temperature on the root surface during laser irradiation. They reported that the retention force on stainless steel was significantly greater than that on nickel-titanium. The maximum temperature increase was 4°C. The temperature increase on the root surface was greater in the vicinity of the welded area than in the apical area. Scanning electron microscopy (SEM) revealed that the files and extractors were welded together. Similar results were found by Tomov (unpublished data, Fig. 3).

In vitro study

Cvikl et al. used a brass tube charged with solder and placed at the coronal end of the fractured instrument in their in vitro experiment.1 Nd:YAG laser energy was used to melt the solder, connecting the fractured instrument with the brass tube. They reported that the fractured endodontic instruments were removed successfully in 17 out of 22 cases (77.3 per cent) in which more than 1.5mm was tangible. When less than 1.5mm was tangible, the removal success rate decreased to three out of 11 cases (27.3 per cent).

These results obtained from in vitro experiments indicate that the laser welding method is effective in removing broken instruments from root canals, but its efficacy has to be further verified in clinical trials.

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By Dr Ross Cutts, UK

Whether we like it or not, we are embracing the digital era in our brave new world. Many dental practices are now becoming paper-free – a digital innovation – and even using tablet computers to record patient details and medical histories. We are continually surprised by the rising age of the technologically savvy patient, particularly those of a certain generation who perhaps we assume would be less so than the perceived iPhoners generation. This change in the patient demographic and attitude towards technology is filtering through to us in the dental profession. The nuts and bolts of implant dentistry tends to lend itself more readily to the digital revolution of dentistry in the UK and now globally. Many practitioners opposed to or reluctant to embrace it are actually being influenced by it through shifting workflows in dental laboratories, even where more traditional clinical practices are followed chairside. Quite often, wet impressions are poured and stone models are scanned to produce STL files for laboratories to process during crown and bridge unit manufacturing. As an implant clinician, one does not have to invest in a CT scanner or chairside intraoral scanner – there are ways that other centers and laboratories can provide these services. However, having these tools at one’s disposal greatly increases one’s efficiency and means one is not reliant on external services for one’s patients.

Mastering the implant digital workflow

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So how do we begin the implant digital workflow? Successful implant treatment begins with thorough case assessment and planning of the proposed restoration. This is important for all cases, not just what we deem the complex ones. Even the most experienced implant clinician can miss a potential treatment planning hazard, especially during a busy day. Accurate study model casts are an essential part of this; however, we can now use intraoral scans preoperatively to begin the digital workflow. We take a scan rather than impressions to form digital models. Our laboratory can then use these to create digital wax-ups of proposed treatment outcomes.

We are routinely used to 2-D radiographic imaging techniques in dentistry, but with the availability and access to CBCT scanning devices now, we are able to assess bone quantity and quality of proposed implant surgical sites. With ever-reducing doses of 3-D imaging and improving accuracy, we are able to use CBCT scans, combined with clever software packages such as CoDiagnostiX (Dental Wings), to plan safe and accurate implant placement and restoration. We are able to preoperatively plan precise implant placement with safe surgical margins away from important anatomical structures, such as the inferior alveolar nerve or maxillary sinus. From this, we are then able to design and either mill or print a surgical guide to use for precise implant placement.

Even with assisted surgery or guided surgery, there are sometimes certain restrictions that prevent us from achieving the most ideal implant placement, such as this case shown where posterior access in the second molar region was reduced, so achieving the perfect parallel was extremely difficult.

There are fully guided systems available that allow for absolutely precise implant placement, but these are fraught with complexities and should be reserved for experienced clinicians. The accuracy of surgical guides should not be used to make up for a lack of surgical competency however.

There are many factors to be considered when using surgical guides, including whether the guide is tooth-, soft tissue or bone-supported. Tooth-supported allows the greatest degree of accuracy. If tooth-supported, are there windows in the guide that direct full seating of the guide? Are the teeth that support exact positioning of the guide mobile? Any mobility adds a degree of inaccuracy—/ is the guide made from a direct intraoral scan or a scan of a study model? If scanning a study model, is this an accurate stone model representation?

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Otherwise, there is the risk of poor seating and inaccuracy of the guide. If soft tissue-supported, mobility completely negates any accuracy of the guide, so it should only be used for a pilot drill and then a more conventional surgical protocol adopted.

If bone-supported, raising of a very large surgical flap is likely—/ it is very difficult to ensure accurate full seating of a bone-supported guide in the precise planned position and this relies upon external fixation.

Once the implants are placed in situ and fully integrated, we then have a choice of conventional wet impression techniques versus digital intraoral scanning. For the majority of cases, intraoral scanning is extremely predictable and reliable—more so than conventional techniques—with milled (and lately printed) models having excellent properties and less accumulation of processing errors. However, deep soft tissue placement relative to adjacent teeth with deep contact points are very difficult to scan and pick up. Straumann tissue level implants offer a very straightforward restorative platform to scan from. With greater numbers of implants and fewer teeth to act as reference points, intraoral scanning becomes less reliable—particularly across the arch—so we need to exercise caution and be aware of its limitations. We have used composite flow stick to the soft tissue to increase reference points for our scanners, increasing their ability to stitch images more accurately together. With this in mind, we cannot assume the scan is accurate and any framework fabricated would be non-passive; therefore, we must use other methods to verify the scan’s accuracy. We have found locking temporary abutments within a composite framework introrally the easiest and most reproducible way to do this. It then allows us to design and mill a truly passive framework by Createch and a temporary acrylic bridge.

Conclusion

There are many opportunities to opt in and out of using technology regarding the digital implant workflow. For anyone considering capital investment, the most important question to ask is, how will or can this improve the outcomes I provide to my patients, and then determine whether that warrants the expenditure. Too often are we subjected to sales pitches of the next biggest gadget and gizmos end up as a part of our investment, the most important thing by company sales representatives and gadgets and gadgets and gizmos end up by the wayside.

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