Impression-Making in 2020: How Long Before Analog Methods Are Obsolete?

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Impression-making is a necessary part of providing restorative and rehabilitative dentistry to patients. The use of physical impression trays and materials dates back to at least the 19th century, which included the development of corrective and functional impression techniques.[1] This method of acquiring and conveying information remained largely unchanged throughout the 20th century, although the development and subsequent improvement of elastomeric impression materials greatly enhanced the quality and predictability of impression results. Now with the digitization of the dental profession, the introduction and advancement of digital impressions represents the latest step forward in impression-making. This article reviews the current state of physical impression-making and the relative advantages and disadvantages of digital impressions.

Analog Impressions: "Old Faithful"

For most practicing dentists, impression techniques and materials have remained unchanged during their practicing lifetimes. The use of irreversible hydrocolloid, ie, alginate, was adopted in the 1940s and continues to be one of the most commonly used impression materials in dentistry. Alginate has the advantages of being inexpensive, fast setting, and relatively accurate, making it still the most prominent material for study casts and orthodontic records. A faster way to produce a model than with an alginate impression and quick-setting gypsum stone has yet to be developed, hence this method continues to be used in offices for orthodontic retainer fabrication and items such as bleaching trays and interim removable partial dentures (RPDs). Even for fabrication of complete dentures and metal framework RPDs, single-step alginate impressions have been shown to work equally as well as other impression methods and materials.[2,3] Alginate does have some disadvantages, namely a short window of time in which it is accurate and the fact that a model may be poured only once, leaving no room for error.

The development of elastomeric impression materials such as polyether (PE) in the 1960s and polyvinylsiloxane (PVS) in the 1970s represents the most significant advancement in impression-making in the 20th century. Improvements in these materials allowed practitioners to make accurate impressions for fixed and removable prosthodontic procedures, largely because of their high elastic recovery and resistance to tearing. When compared to alginate, PVS offers several clear advantages: most notably, it remains dimensionally stable for weeks instead of minutes, and it allows for pouring of multiple models from the same impression. PE materials are hydrophilic in nature, which is an obvious advantage in the oral cavity, but they are relatively stiff, which can lead to less accuracy when compared to PVS for full-arch impressions. PE is also more sensitive to storage conditions; while both PE and PVS impressions can lose accuracy over storage time, PE degrades faster.[4] PVS has long been considered the "gold standard" for impression materials in terms of accuracy, however it is hydrophobic in nature, which may present clinical challenges.

In the early 2000s, in an effort to overcome the shortcomings of PE and PVS, a new impression material category was created that combined the two materials: polyvinyl ether siloxane (PVES). Existing data on PVES is scarce. Some in vitro data shows PVES to be more hydrophilic than PVS,[5] but perhaps less hydrophilic than PE,[6] and less able than PVS to reproduce surface detail.[7] Also in the early 2000s, PVS formulations were altered to make certain viscosities more hydrophilic and to incorporate the use of surfactants; these developments led to a general improvement in outcomes when compared to earlier PVS products.[8,9]

Despite their proven efficacy and predictability, all physical impressions have several inherent drawbacks. Regardless of material, physical impressions have a limited window of usability, and the resultant physical model produced takes up physical space, which can become logistically problematic when the models are required by law to be stored. The information transfer provided by a physical impression can be distorted at any point in the process—during the impression-making, during transfer of the impression to the lab, or during subsequent fabrication and working of the stone model.

The primary disadvantage of analog impressions, however, is their inherent nature: they're physical. Today most restorative and rehabilitative dental solutions are produced digitally. A physical impression must first be digitized, or a model poured and digitized, before the information can be used to generate the desired outcome. A lack of integration with today's digital workflows creates not only a less efficient and more complicated workflow, but also another opportunity for data integrity to be lost during the transfer between analog and digital.

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Digital Impressions: The New "Conventional"

The emergence of chairside CAD/CAM restorations in the 1980s brought with it a new method of acquiring intraoral data: the digital impression. Early scanners employed static digital photograph technology and required the use of titanium dioxide powder as a contrast medium, and their sole purpose was to provide data for the fabrication of a single-unit restoration, with no integration with other workflows. Today in 2020 the landscape is vastly different. Contemporary intraoral scanners capture images at video rate speed, usually do not require the use of a contrast medium, and can accurately capture full-arch data. With laboratory workflows shifting toward the use of CAD/CAM, digital data acquisition can be seamlessly used to fabricate not only single-unit restorations, but also full-arch implant-supported restorations and everything in-between.

With outcomes for digital impressions constantly improving, this medium is quickly emerging as the new benchmark for accurate impression-making. Substantial data already exists showing digital impressions to be equal to or better than analog impressions for fabrication of single-unit restorations.[10-12] They also have been shown to be just as accurate for implant-supported prostheses.[13] Moreover, digital impressions may be used for more than just restorative dentistry; one systematic review for orthodontics suggests that digital impressions should be considered the new "gold standard" for orthodontic records.[14] For dentate full-arch impressions, older scanning technology has already been shown to be more accurate than alginate and PE,[15] and recent data suggests that there is no significant difference between several digital scanners on the market and PVS impressions.[16] Furthermore, while analog impression quality has mainly stagnated over the past decade or more, digital impression quality continues to improve at a rapid pace, being refined seemingly daily as software algorithms and scanner hardware progress.

Digital impressions provide several key advantages over their analog counterparts. In addition to equaling or exceeding analog impressions in terms of accuracy, digital impressions seamlessly integrate with modern laboratory workflows. This facilitates a more efficient workflow with regard to time and cost, thus benefiting the laboratory, clinician, and, ultimately, patient. Digital data acquired can be instantly shared, does not degrade with time, and is easily stored. Additionally, the integration with other emerging technologies, such as 3D imaging and digitally driven orthodontic treatment, creates opportunities for complex interdisciplinary treatment in ways that are not possible in an analog environment. As 3D printing speed and accuracy improve, it appears to be only a matter of time before even "grabbing a quick alginate" will be replaced by a digital scan and 3D-printed model. Moreover, patients generally prefer the digital impression experience to the physical one.

Digital impressioning, however, is not without some obstacles and disadvantages. The transition from analog to digital can be challenging for some clinicians, given that most practitioners did not receive training for digital impressioning in school. Although an increasing number of digital scanners are quite cost-effective today, the initial investment to acquire a scanner is obviously more than a box of impression trays and impression material. Also, fully edentulous situations in which implants are not involved present a challenge for digital scanners because of the relative lack of data density and the current inability to capture a "functional" impression digitally. Finally, with an ever growing array of digital scanners on the market, it is becoming increasingly hard for practitioners to understand and decide which scanner's digital ecosystem might be best for their particular practice, as each system has its own benefits and shortcomings relative to cost, ease of use, and connectivity.

Welcome, 21st Century

While analog impression methods still have a place in modern dentistry, their usage is quickly declining. Digital workflows are steadily making analog workflows for patient care obsolete. It seems only a matter of time before the impression tray, a relic of 19th and 20th century armamentarium, is relegated to the dental museum.

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