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Letter to the Editor

New directions in old leakage methods….

It was not a surprise when I read the recent Editorial in the *Journal of Endodontics* (JoE) that set-out the case for refusing to consider the publication of certain types of experimental laboratory studies on leakage of root fillings (*Journal of Endodontics* 2007; 33: 1401–2). As the Editorial stressed, a substantial number of studies have claimed to evaluate the quality of the apical seal using an array of methods; however, clear conclusions on the appropriateness of these leakage methodologies remain elusive. Dye leakage and the other leakage methods have a questionable scientific significance. Our research group has some experience with bacterial and glucose leakage as well as the fluid transport model. Thus, we are conscious of the limitations of these methods. However, I believe that the key publication responsible for the debate on leakage studies and our comprehension of such studies was the defining paper of Wu & Wesselink (1993).

Studying sealability in endodontics in the beginning of the 90s, Wu *et al.* (1993, 1994a) adapted the fluid transport method to evaluate root fillings. Since its introduction, this fluid transport experimental set-up has been employed by several research groups (Wu *et al.* 1994b, Abramovitz *et al.* 2001, Pommel & Camps 2001, De-Deus *et al.* 2008), and as a consequence, its advantages are well known. Today, the fluid transport model still represents a reliable method to study sealability in endodontics. However, the fact remains that the clinical significance of the results of fluid transport studies are unknown.

In 2005, a new and innovative method to evaluate sealability was developed and referred to as the glucose leakage model (GLM) (Xu *et al.* 2005). In the GLM, glucose solution is used as a tracer and this methodology was accepted by an established research group as an improvement over the fluid transport method (Shemesh *et al.* 2006). The GLM represents an advance in methodology and has the potential to add value to the conclusions of laboratory leakage studies, particularly as glucose entering the root canal from the oral cavity could lead to multiplication of bacteria that might survive root canal preparation and filling and potentially lead to peri-apical inflammation (Xu *et al.* 2005). Therefore, the use of the GLM is thought to be more relevant than other tests (Xu *et al.* 2005, Shemesh *et al.* 2006), but again, its clinical significance remains to be determined.

Using an innovative approach, Oliver & Abbott (2001) were the first to attempt to determine the clinical relevance of laboratory leakage studies. These authors employed extracted root filled teeth to determine the correlation between dye leakage and the clinical outcome of treatment. They concluded that the results of dye leakage studies were not relevant from a clinical standpoint. However, it must be noted that the authors employed a linear dye leakage model and more reliable and sophisticated leakage models remain to be tested in this way. Almost 5 years passed until another research group investigated extracted root filled teeth. Susini *et al.* (2006) used dye extraction as the laboratory model; the advantages of this model over linear dye leakage are well documented in the literature (Hashem & Hassanien 2008). Yet again, that study did not find a positive correlation between dye leakage and the presence of peri-apical pathosis as determined from radiographs. Nevertheless, the results of the dye penetration did correlate with the technical quality of the root filling as judged radiographically. Many reasons can explain these findings; but it is important to remember that an association was established between the *in vivo* status of the root fillings and the results of a laboratory test.

At this point in time, it is not difficult to understand the critics of laboratory leakage studies. Thus, it is an appropriate moment to stimulate further research on extracted root filled teeth to determine the clinical relevance of laboratory leakage tests. In other words, it is time to stop undertaking simple comparisons of the sealing ability of endodontic materials or techniques, as we first have to determine the clinical significance of laboratory leakage models. Rather, it is time to concentrate efforts to verify the value of laboratory methods considered to be more reliable, such as: fluid transport, bacterial leakage, dye extraction and glucose leakage penetration. However, it is worthwhile mentioning that this type of research is not trivial. To obtain extracted root filled teeth is not simple and ethical considerations must be dealt with adequately. Furthermore, both clinical and laboratory studies must be managed effectively by the research group.

However, the product of this research will be crucial to Endodontics and to the better understanding of the role of leakage in the outcome of root canal treatment. It will take several years before the endodontic community will be able to interpret and fully comprehend the results of these potential studies.

Optimistically, the role of laboratory leakage studies will be elucidated and a solution to the question whether laboratory leakage studies can anticipate, with reliability, the clinical performance of either a material or a technique? Examples from the literature on adhesive restorative materials are available, where some clear associations were detected when laboratory and *in vivo* bonding effectiveness data were correlated (Van Meerbeek *et al.* 1998, De Munck *et al.* 2005). Adhesives that performed less well in several independent laboratory studies also appeared to be less effective clinically. So, in contrast to some views within the endodontic community, clinical effectiveness of adhesives can be predicted in part by laboratory findings (Van Meerbeek *et al.* 1998, De Munck *et al.* 2005). This may be a consequence of the stronger evidence-based level of the adhesive restorative studies. Nevertheless, if this kind of association could be deduced from endodontic studies, it would represent a considerable evolution in the assessment of the new root filling materials and techniques.

Hopefully, the results of studies evaluating laboratory leakage and clinical outcomes will create a better evidence base to support the use of specific materials and techniques when filling canals for the benefit of patients.

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Response

Dear Editor,

I agree with Dr De-Deus that the findings of Oliver & Abbott (2001) and Susini *et al.* (2006) could be interpreted in a number of ways. Firstly, linear dye penetration only measures the length of the longest void in a root filling; clearly, the results of such measurements do not provide sufficient information to make valid conclusions on the sealing ability of root fillings (Wu & Wesselink 1993, Camps & Pashley 2003). Whether the results of other leakage