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Efficacy of irrigant activation techniques in removing intracanal smear layer and debris from mature permanent teeth: a systematic review and meta-analysis

Aim To establish whether Irrigant Activation Techniques (IAT)
result in greater intracanal smear layer and debris removal than
Conventional Needle Irrigation (CNI).

Methodology Six electronic databases (PubMed, EMBASE,
Cochrane Library, Science Direct, Web of Science and Google
Scholar) and supplemental sources were searched by two review-
ers from 01.2000 to 11.2016 to identify scanning electron micro-
scopy studies evaluating smear layer and/or debris removal
following use of Manual Dynamic Activation (MDA), Passive
Ultrasonic Irrigation (PUI), Sonic Irrigation (SI) or Apical Nega-
tive Pressure (ANP) IATs in mature permanent teeth. Meta-ana-
lyses were performed for each canal segment (coronal, middle,
apical and apical 1 mm) in addition to subgroup analyses for
individual IATs with respect to CNI. Outcomes are presented as
Standardised Mean Differences (SMD) alongside 95%-Confidence
Intervals (CI), to allow direct comparisons between studies that
used semi-quantitative scoring systems to evaluate intracanal
cleanliness.

Results From 252 citations, 16 studies were included in the
qualitative analysis and 12 in the meta-analysis. Nine studies
investigated smear layer, 1 debris and 12 examined both with
ANP ($n = 10$) and PUI ($n = 10$) being most commonly tested fol-
lowed by SI ($n = 7$) and MDA ($n = 6$). The meta-analysis demon-
strated significant improvements in the coronal (SMD: 1.15/CI:
0.72–1.57, SMD: 0.54/CI: 0.29–0.80), middle (SMD: 1.30/CI:
0.59–2.53, SMD: 0.8/CI: 0.58–1.13) and apical thirds (SMD:
1.22/CI: 0.83–1.62, SMD: 1.86/CI: 0.76–2.96) for smear layer
and debris removal respectively. In the apical 1 mm, IATs
improved cleanliness; however, the differences were insignificant
(SMD: 1.15/CI: −0.47–2.77). The most effective IATs in the coro-
nal third were SI (SMD: 1.29/CI: 0.76–3.41) for smear layer and
ANP (SMD: 0.62/CI: 0.12–1.12) for debris, and for the middle
third were SI again (SMD: 2.21/CI: 1.20–3.22) and PUI (SMD:
1.26/CI: 0.77–1.74). In the apical segment MDA removed the
greatest quantity of both smear layer (SMD: 1.50/CI: 0.62–2.37)
and debris (SMD: 2.22/CI: 1.19–3.26).

Conclusions Within limitations of this study, IATs were found
to significantly improve intracanal cleanliness across a substantial
portion of the canal. Therefore their use is encouraged during
routine root canal treatment. No single technique produced the
highest impact across all regions hence a combination of machine
and hand assisted IATs is postulated to result in greater efficacy.
Based on this review and surrounding literature SI in combina-
tion with MDA, the latter being equally effective as ANP at the
apex, is likely to lead to the greatest smear layer and debris
removal throughout the canal. Further *in vivo* experiments are
required to understand the impact this would have on periapical
healing.