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Deflection of Conventional Versus Nondeflecting Dental Needles in Vitro

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Summary
Deflection of conventional and newly introduced nondeflecting dental local anesthetic needles were compared in vitro by radiographic examination of the course of the needles in a hydrocolloid impression material. Results indicated significantly less deflection of the new needles when compared to a variety of conventional needles. Controlled clinical trials will be required to test the significance of this finding.

Factors affecting the deflection of dental local anesthetic needles include needle gauge and length, the consistency of tissues being pierced, depth of needle insertion, and the needle tip design. Aldous suggested that excessive deflection of fine-gauge, dental local anesthetic needles could contribute to failures of local anesthesia, especially during injections which require relatively deep needle penetration, such as the inferior alveolar nerve block. Recently, a 28-gauge dental needle with a “nondeflecting” tip design was introduced. Conventional needle tips, by token of having a rather long, straight bevel, may contribute to deflection as the needle passes through resistive tissues. A nondeflecting tip design would theoretically limit needle deflection by guiding the needle on a straighter course through tissues.

Reversible hydrocolloid has been shown to provide a suitable medium for assessment of local anesthetic needle deflection in vitro, since its homogeneity precludes the introduction of variables in consistency which would be present in an experimental system using natural mammalian tissues. The present study was designed to compare the relative deflectabilities of a conventional local anesthetic needle and a newly marketed “non deflection” needle in a homogeneous medium.

Methods
The conventional needles used for these studies were Monoject long 25-gauge, and short and long 27-gauge (Sherwood Medical Industries, Inc., Deland, Florida). The nondeflecting needles used were long and short 28-gauge, marketed under the trade name Tru-ject (Cannulae Corporation, Los Angeles, California). According to the manufacturer, deflection of this needle is reduced by bending the tip toward the midline of the needle lumen after a bevel has been ground (see Figs. 1 and 2). This concomitantly reduces coring area by 75%, thus reducing the amount of tissue captured in the needle lumen as the tip is advanced, as well as contributing to decreased deflection. A special baked-on silicone coating is also used on the nondeflecting needle to reduce drag through tissues.

The technique used to measure deflection was based on the technique previously reported by Aldous. Needles obtained from a local dental supply company were mounted in the movable shaft of a dental surveyor, under which a tube of room temperature, reversible hydrocolloid was placed. The needles were then introduced into the hydrocolloid and pushed into the material until the hub was contacted. Tip-to-hub lengths of the various needles are given in Table 1. After maximal insertion was achieved, radiographs of the hydrocolloid chamber were made in two planes, using Rinn extension cone-paralleling devices to insure consistent positioning of the x-ray tube. Multiplane radiography assured that maximum deflection could be detected. A vertical metal rod held outside the hydrocolloid chamber appeared on the radiographic image and provided a true vertical axis from which needle deflection could be measured. Maximal deflection of the tips from the vertical reference was measured in millimeters (to the nearest 1/10th mm) for 10 needles in each of the following groups:

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Deflection values in the groups were compared statistically using Student’s unpaired t-test. Scanning electron micrographs of the nondeflecting and conventional local anesthetic needle tips were made using a standard electron microscopic technique.

**Results**

Deflection values for each group are presented in Table 1. Reported values include vertical penetration depth, maximum horizontal deflection of the tip, and millimeter deflection per centimeter insertion.

It is clear that both the long and short nondeflecting needles consistently gave lower deflection values than the conventional needles. Even the conventional 25-gauge long needle, widely recommended for its greater rigidity, deflected to a significantly greater degree than the 28-gauge nondeflecting long needle in reversible hydrocolloid.

**Discussion**

Previous studies of dental needle penetration *in vitro* have demonstrated that the amount of deflection was inversely proportional to needle gauge; that is, thicker needles deflect less than thinner ones. The present study, however, has demonstrated that a 28-gauge needle with a specially modified, nondeflecting tip produces less needle deflection than a 25-gauge needle with a conventional tip. This would suggest that a thicker needle *per se* will not minimize deflection (at least in the range of needle gauges used in dentistry), and that tip design is perhaps more important than gauge in reducing deflection. In this

![Fig. 1](image1.png)

Fig. 1—Scanning electron micrograph (side view) of tip of conventional dental needle (Monoject® 27-gauge long), showing bevel cut toward a straight side (arrow). This places the needle tip at the extreme side of the needle.

![Fig. 2](image2.png)

Fig. 2—Scanning electron micrograph (side view) of tip of nondeflecting dental needle (Tru-ject® 28-gauge long), showing bend toward the bevel (arrows). This places the needle tip at approximately the center of the long axis of the needle (× 1000).

<table>
<thead>
<tr>
<th>Needle</th>
<th>Maximal tip deflection (± SD)</th>
<th>Deflection coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-Gauge long (nondeflecting)</td>
<td>1.1 ± 0.82</td>
<td>0.29 ± 0.21</td>
</tr>
<tr>
<td>27-Gauge long (conventional)</td>
<td>8.4 ± 1.2*</td>
<td>1.90 ± 0.27*</td>
</tr>
<tr>
<td>25-Gauge long (conventional)</td>
<td>7.1 ± 0.81*</td>
<td>1.60 ± 0.16*</td>
</tr>
<tr>
<td>28-Gauge short (nondeflecting)</td>
<td>0.8 ± 0.91</td>
<td>0.30 ± 0.34</td>
</tr>
<tr>
<td>27-Gauge short (conventional)</td>
<td>4.6 ± 0.97**</td>
<td>1.50 ± 0.32**</td>
</tr>
</tbody>
</table>

*Table 1. Maximal Tip Deflection (in mm) and Deflection Coefficient (in mm/cm insertion) for Various Dental Needles*

1. Denotes statistically significant difference from nondeflecting long needle at p<0.01, n=10 needles in each group.
2. Denotes statistically significant difference from nondeflecting short needle at p<0.01, n=10 needles in each group.
connection, another study demonstrated significantly less force required to insert a smaller gauge needle. This improved penetrability may contribute to decreased deflection if it allows the needle to penetrate through, rather than deflect around, various tissues encountered during a dental injection. While it is obviously difficult to extrapolate clinical predictions from an in vitro study, it would appear that, based on the data presented here, fewer local anesthetic failures could be attributed to needle deflection per se when using the new nondeflecting tip design.

Despite the reduced deflection offered by the new 28-gauge needle reported here and the improved penetrability of smaller needles, one cannot disregard the increased safety offered by larger dental needles (e.g., 25 gauge). Until controlled clinical trials demonstrate superiority of the smaller gauge needles, with breakage resistance equal to that of 25-gauge needles, the authors will continue to recommend the use of 25-gauge needles for block injections.

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References