Intraligamental analgesia for post-operative pain control in children having dental extractions under general anaesthesia

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ABSTRACT: Aim This was to assess the effectiveness and safety of intraligamental local analgesia (ILA) for post-operative pain control in children having dental extractions under general anaesthesia (GA). The variables affecting the effectiveness of ILA were also investigated. Methods Data were collected from children having permanent molars extracted under GA using a randomised half mouth study design. ILA (bupivicaine 0.5% with 1:200,000 adrenaline) was used on the randomly assigned experimental side prior to extraction of the teeth, and the contralateral control side received no ILA. Children were interviewed pre- and post-operatively by the principal investigator (PA) who was blind to the side of ILA. Pre- and post-operative anxiety levels of each child were measured using the Venham Picture Test (VPT). Patients were asked to rate which side was better in terms of pain control, whether they felt numbness and whether they preferred the numbness. Their post-operative pain levels were also measured using the visual analogue scale (VAS). Self-inflicted trauma following ILA was noted. Results Thirty children, with a mean age of 11.3 years (SD±1.7) completed the study. None of the patients had self-inflicted soft tissue trauma following ILA. Nineteen children (63%) found that pain control was better post-operatively on the side with ILA. Twenty-one children (70%) reported numbness following ILA of whom 14 (67%) said that they preferred this. VAS scores were not significantly different between the experimental and control sides. A higher percentage of boys (85%) than girls (47%) rated the ILA side “better” (p=0.034). VPT scores were significantly higher for girls postoperatively (p=0.048). Conclusion ILA was a useful and safe adjunct for postoperative pain control in children having permanent teeth extracted under GA. The technique was found to be more effective in boys than girls. However, less than half the children in this study preferred the side with numbness. Further research is needed to determine effective methods of pain control in children following dental GA and to investigate the reasons for gender differences of pain perception in children.

KEYWORDS: Intraligamental analgesia, Pain control, Children, Dental GA.

Introduction

General anaesthesia (GA) is sometimes necessary for the provision of dental care to anxious children. A certain proportion of children requiring extractions of hypomineralised and/or carious first permanent molars are incapable of accepting this treatment under local analgesia (LA), even with the use of inhalation sedation. It is not surprising that dental extractions under GA during childhood may contribute significantly to dental fear and anxiety in adults, as pain has been reported in 32 to 70 percent of children following such procedures [Fung et al., 1993; Zaidi, 2002; Atan et al., 2004]. Furthermore, children who have fearful dental experiences are more likely to avoid dental care as adults [Berggren and Meynert, 1984]. Thus, paediatric dentists have a responsibility to provide dental care to the child patient, which is as pain-free as possible.

Oral, rectal or intravenous analgesia administered pre-, intra- and post-operatively are the mainstays of pain control in children having dental extractions under GA in the United Kingdom (UK) and are used with varying degrees of success. An advantage of analgesia, before the onset of a painful stimulus, may be its ability to pre-empt pain experienced subsequently [McQuay et al., 1988; McQuay, 1992; Bush, 1993].

LA, delivered by infiltration or block technique, may also be used for post-operative pain relief in patients having dental extractions under GA. However, unwanted soft tissue anaesthesia may outweigh the benefit of effective pain control post-operatively. Another disadvantage of infiltration or regional anaesthesia techniques in children is that they sometimes find it difficult to distinguish between numbness and discomfort.
Intraligamental analgesia (ILA), a form of intraosseous anaesthesia, is a method of providing LA by injecting a local anaesthetic solution into the periodontal ligament space. One of the major advantages of ILA, compared with infiltration/block technique, is that there is negligible soft tissue anaesthesia [Meechan, 2002] which may improve its acceptability to children. Another possible advantage of ILA may be that the chances of children traumatising their surrounding soft tissues should be minimal. Finally, the volume of LA solution required to produce analgesia is reduced.

ILA, in addition to systemic analgesia, has been used successfully to reduce post-operative pain in adults undergoing surgical extractions of third molars under GA [Campbell et al., 1997]. The use of systemic analgesia for the management of post-operative pain in children following dental extractions under GA is well documented. However, there have been few publications on the use of LA for post-operative pain control in children having dental extractions under GA.

The aims of the study were to assess the effectiveness of intraoperative ILA for post-operative pain control in children having dental extractions under GA, to determine the variables influencing the effectiveness of ILA and to measure the frequency of complications, such as self-inflicted injury, following ILA.

Materials and methods

Sample selection. Healthy children (ASA I or II), attending the day-stay GA unit at Guy’s Hospital (UK), who were 6 years of age or more, and required symmetrical extractions of permanent teeth on contra-lateral sides of the same jaw, were invited to participate in the study. Following local ethics committee approval, informed consent was obtained for all the subjects by their parents.

In all, 30 children, 13 males and 17 females, with a mean age of 11.3 years (SD 1.7) participated in the study. Of these, 24 children had all first permanent molars extracted, 5 had maxillary first permanent molars extracted and 1 child had mandibular first permanent molars extracted. A decision was made to extract the teeth following orthodontic consultation as they were either grossly carious (n=15 patients) or hypoplastic/hypomineralised (n=15) and had a poor long-term prognosis. All the extractions were nonsurgical.

Exclusion criteria. ILA was not used prior to primary molar extractions as animal studies have shown this technique may cause damage to the underlying permanent successors [Brannstrom et al., 1984]. Children, in whom ILA was contraindicated, such as those at risk of infective endocarditis and those with acutely infected teeth, were excluded. Finally, children with learning difficulties, who would be unable to complete the required questionnaires, were also excluded.

Pre-operative assessments and investigations. All interviews and recordings were carried out by the principal investigator (PA) as shown in Table 1. Medical and dental histories were obtained including previous experience of GA and LA. Baseline anxiety levels of the parents and children were measured using the Corah Dental Anxiety Scale [Corah, 1969a; Corah, 1969b; Corah et al., 1978] and the Venham Picture Test (VPT) [Venham, 1979], respectively. In addition, the patient’s pre-operative blood pressure (BP) and heart rate were recorded to measure the patient’s anxiety level [West, 1983]. The number and type of teeth extracted on each side of the mouth were recorded, and the indications for extractions. The dose and type of systemic analgesics given to the children were noted.

Intra-operative procedure and assessment for ILA technique and dental extractions. Systemic analgesics during the GA was received by 28 children, which comprised IV ketorolac (16 patients), IV alfentanil and ketorolac (1 patient), IV alfentanil (2 patients), suppository diclofenac sodium either alone (4 patients) or in combination with IV alfentanil (3 patients), and paracetamol suppository (2 patients). Ten children received paracetamol orally and 5 received ibuprofen prior to being discharged.

Standard GA procedures were used in all patients who were maintained on nitrous oxide/oxygen/and sevoflurane. Laryngeal mask intubation was used in 26 patients and the remaining 4 had endotracheal tube intubation.

Each patient acted as his/her own control using a half-mouth study design. One side of the mouth was randomly selected for administration of ILA by one of 3 operators using a Citoject ILA syringe (Claudius Ashe, UK),

**Table I - Summary of timing of assessments of the children in a study of intraligamental injection for tooth extraction under general anaesthesia.**
keeping the principal investigator blind to the side of analgesia. Approximately 0.2 ml of bupivacaine (0.5%), with 1:200,000 epinephrine (Dentsply DeTrey, UK) was administered per root of each tooth being extracted. Each operator waited at least 2 minutes following the ILA, before extracting the anaesthetised tooth in order to give sufficient time for the LA to take effect. The same operator who administered the LA performed all the dental extractions required for each subject. Any intra-operative analgesics given to the patients were noted. The drugs used and the types of GA (e.g., laryngeal mask, or oral/nasal intubation) were recorded.

Post-operative assessment. A. Questionnaire. The principal investigator carried out all post-operative assessments and interviews. On recovery from the GA, the patients scored the level of pain on each side of their mouth using a 100 mm Visual Analogue Scale (VAS) with end points “no pain” (0 mm) and “unbearable pain” (100 mm) [McGrath, 1987]. They were also asked to rate which side of the mouth felt better with regard to pain, which side felt numb and if numbness was preferred (Table 1).

B. Other data recorded post-operatively. The patient’s post-operative anxiety was assessed using the VPT. Systolic and diastolic BP, and heart rates were also measured. Analgesics given to the patient post-operatively were recorded. Complications associated with the GA, such as nausea and vomiting, were noted. Before discharge, the principal investigator conducted an intra-oral examination to determine any signs of self-inflicted trauma (Table 1).

C. Post-operatively 48-72 hours. The principal investigator phoned the parents of each child 48 to 72 hours later to check for post-operative complications.

Analysis of the data. Data collected from all the completed questionnaires were analysed using STATA Version 8 statistical package (Stata Corporation, Texas, USA). The data were not normally distributed and comparisons were made using non-parametric tests, including the Chi-squared test for categorical variables, the Wilcoxon matched-pairs signed-rank test for within-subject comparisons, and the Mann-Whitney U-test for between subject comparisons. Logistic regression was used to analyse the variables that significantly influenced each child’s rating of which side was “better”. A value of p<0.05 was considered statistically significant.

Results

In all, 30 children, 13 males and 17 females, with a mean age of 11.3 years (SD 1.7), attending the day-stay GA list for dental extractions at Guy’s Hospital, participated in the study. Systemic analgesics during the GA were received by 28 children. Standard GA procedures were used in all patients.

There were no significant differences between the pre- and post-operative heart rates of the children. Post-operative diastolic BP was significantly higher than pre-operative diastolic BP (p=0.017). There was a trend only towards higher post-operative systolic BP compared with baseline systolic BP (p=0.056). None of the patients showed signs of post-operative soft tissue trauma following ILA, nor were there any other complications, except 3 children had vomiting in the early post-GA period. Baseline anxiety levels of the parents (Corah Dental Anxiety Scale) had no correlation to the effectiveness of the ILA.

Fifty percent of children had previous experience of LA. Comparison of variables between children who rated the ILA side better in terms of pain control is shown in Table 2. Nineteen (63%) of children found that pain control was better on the experimental side postoperatively. Twenty-one children (70%) said that they felt numbness on the experimental side while the remainder did not or were undecided. Of the children who found that pain control was better on the experimental side, 24 reported feeling numbness on this side and 28 stated that they preferred the feeling of numbness.

The pain scores for the experimental and the control sides of the mouth in the maxilla and mandible are shown in Table 3. All the children reported some pain using the VAS on either the experimental or control sides of the mouth or both. While the VAS scores were lower for the experimental side compared with the control side, the differences were not significant.

A higher number of boys (11/13) than girls (8/11) rated the experimental side better (p=0.034; Table 4). The VAS scores were significantly lower for boys than girls on the experimental side in the maxilla and mandible (p=0.003 and p=0.002, respectively) but not on the control side. There were no significant differences between the VPT scores for boys and girls pre-operatively, but the VPT scores were significantly higher for girls than boys post-operatively (p=0.048; Figs. 1 and 2). The boys were significantly older than girls (p=0.008). Previous LA experience was similar for both boys and girls. There was no significant difference between the length of time taken for extractions in boys and girls or the pre- and post-operative systemic analgesics prescribed to either gender. Finally there were no significant differences between genders for either heart rate or blood pressure.

A logistic regression model clustered within subjects found that 26% of the variation in the patient’s self report of better pain control on the experimental side could be explained by the variables: VAS (p=0.004); gender (p=0.028), and feeling of numbness on the experimental side (p=0.028).
### Table 2 - Comparison of variables between subjects who rated experimental and control side of mouth “better” in terms of pain control in a study of intraligamental injection for tooth extraction under general anaesthesia (*significant, p<0.05).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental side better (n = 19)</th>
<th>Control side better (n = 11)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>12.00 (10.00-13.00)</td>
<td>11.0 (10-12)</td>
<td>0.51</td>
</tr>
<tr>
<td><strong>Pre-operative wait (mins)</strong></td>
<td>120 (100-165)</td>
<td>120 (65-155)</td>
<td>0.34</td>
</tr>
<tr>
<td><strong>Pre-operative Venham Scale score (0-8)</strong></td>
<td>2 (0-3)</td>
<td>1 (0-3)</td>
<td>0.74</td>
</tr>
<tr>
<td><strong>Post-operative Venham Scale score (0-8)</strong></td>
<td>2 (0-2)</td>
<td>3 (0-5)</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>Parent’s Corah Dental Anxiety Scale score (4-20)</strong></td>
<td>12 (9-15)</td>
<td>9 (8-13)</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Previous experience of LA</strong></td>
<td>9</td>
<td>6</td>
<td>0.71</td>
</tr>
<tr>
<td><strong>Pre-extraction analgesia</strong></td>
<td>6</td>
<td>6</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Numbness felt on experimental side</strong></td>
<td>15</td>
<td>6</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Numbness preferred</strong></td>
<td>14/15</td>
<td>0/6</td>
<td>0.04*</td>
</tr>
<tr>
<td><strong>Post-operative analgesia</strong></td>
<td>11</td>
<td>4</td>
<td>0.26</td>
</tr>
<tr>
<td><strong>Extraction time for upper molars (secs)</strong></td>
<td>30 (8, 71)</td>
<td>50 (35, 65)</td>
<td>0.004*</td>
</tr>
<tr>
<td><strong>Extraction time for lower molars (secs)</strong></td>
<td>36 (15, 78)</td>
<td>45 (43, 78)</td>
<td>0.79</td>
</tr>
</tbody>
</table>

### Table 3 - Median and interquartile range of Visual Analogue Scale pain scores (mm) for the experimental and control sides in maxillary and mandibular arches children in a study of intraligamental injection for tooth extraction under general anaesthesia.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Visual Analogue Scale pain scores (mm)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maxilla (n = 29)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experimental side</strong></td>
<td>18 (10, 39)</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Control side</strong></td>
<td>29 (11, 50)</td>
<td></td>
</tr>
<tr>
<td><strong>Mandible (n = 25)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experimental side</strong></td>
<td>20 (5, 45)</td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Control side</strong></td>
<td>30 (12, 50)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4 - Comparison of boys and girls in relation to responses to questionnaires, and median age and anxiety levels (interquartile range) in a study of intraligamental injection for tooth extraction under general anaesthesia.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Boys (n = 13)</th>
<th>Girls (n = 17)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>13 (10.5-13.5)</td>
<td>11 (10.0-11.50)</td>
<td>0.008*</td>
</tr>
<tr>
<td><strong>ILA side better</strong></td>
<td>11</td>
<td>8</td>
<td>0.034*</td>
</tr>
<tr>
<td><strong>ILA side preferred</strong></td>
<td>8</td>
<td>6</td>
<td>0.61</td>
</tr>
<tr>
<td><strong>Numbness felt</strong></td>
<td>10</td>
<td>11</td>
<td>0.72</td>
</tr>
<tr>
<td><strong>Pre-operative VPT scores (median, interquartile range)</strong></td>
<td>1 (0, 4)</td>
<td>2 (0, 3)</td>
<td>0.88</td>
</tr>
<tr>
<td><strong>Post-operative VPT scores (median, interquartile range)</strong></td>
<td>1 (0, 2)</td>
<td>3 (0.5, 4.5)</td>
<td>0.048*</td>
</tr>
</tbody>
</table>

*ILA=intraligamental analgesia

VPT=Venham Picture Test

*significant, p<0.05
Discussion

The results of the study have shown that ILA may be a useful adjunct for pain control in children having permanent molar extractions under GA. Previous researchers found block administration of bupivacaine 0.5% with 1:200,000 adrenaline to be effective for post-operative pain control in adults having surgical extractions of wisdom teeth [Campbell et al., 1997]. Nineteen (63%) of the children in the present study reported that ILA was better in terms of pain control than the unanaesthetised control side of the mouth. The patients’ verbal response to questions regarding the presence of pain on experimental side of the mouth compared with the control side correlated well with results of the VAS pain scores. While the VAS pain scores were lower for the experimental than control side of the mouth, the relatively small number of subjects in the study may explain why the differences were not statistically different. One other study, with a similar design, investigated the effectiveness of infiltration of prilocaine 3% with felypressin for post-operative pain control in children having primary and permanent teeth extracted under GA [Connolly and Fayle, 2001]. Eighty-three percent of children preferred the side without LA compared with 37% of children in the present study. This difference may be explained by the fact that ILA was used in the present study rather than infiltration technique. Secondly, children in the present study were older and some had previous experience of LA. Thirdly, while pre-operative systemic analgesia was used for the majority of patients in both studies, post-operative systemic analgesics were also given to 50% of children in the present study.

Two other studies, by Jürgens et al. [2003] and by Atan et al. [2004], have reported that LA was “effective” for post-operative pain control in children having extractions, surgery, and/or restorative care under GA. In the latter study, 101/121 of children reported no pain in the immediate post-operative period and the odds ratio of children experiencing pain was reduced if patients received LA. Direct comparison of the findings of these studies with the present study is limited by the fact that the method of delivery of LA was unspecified; post-operative pain was assessed using verbal rating scales only or by observing the children’s behaviour following their recovery; wider age range of children was used; and in one study, 64/121 of children underwent surgical procedures [Atan et al., 2004]. There was no attempt to standardise systemic analgesia in our study. All but one child received pre-operative systemic analgesia and half had post-operative oral analgesia before being discharged. No relationship could be found between those who had lower VAS scores, and the amount or type of systemic analgesia pre-operatively or post-operatively. If similar studies will be carried out in future a suggestion may be to use a standardised protocol for systemic analgesia for all patients to avoid confounding factors.

In the present study, there were no complications, such as self-inflicted soft tissue trauma, following the use of ILA, which may be an advantage of ILA over block and infiltration analgesia. Previous similar studies have not reported on post-operative complications following LA. An interesting finding of the present study was the influence of gender on the children’s response to pain. The lower levels of post-operative pain reported by boys than girls could not be explained by the frequency or amount of pre and post-operative systemic analgesics prescribed to either group, previous experience of LA, or length of time for extractions as each of these variables were not significantly different for boys and girls. Previous research has shown that time taken for extractions in adults did not significantly influence the amount of post-operative pain experienced by patients [Seymour, 1985]. One could also speculate that the significantly older age of the boys or the higher post-operative levels of anxiety amongst girls may account for some of the variation in their response to pain. However, this could not be proven by the present study. Previous researchers have found that women reported more dental anxiety than men and younger individuals were more dentally anxious than older ones [ter Horst and de Wit, 1993; Liddell and Locker, 1997]. However, the

**Fig. 1** - Pre-operative Venham Picture Test (VPT) scores for boys and girls.

**Fig. 2** - Post-operative Venham Picture Test (VPT) scores for boys and girls.
latter study concluded that postoperative pain was higher in men than women. Seymour et al. [1983, 1985] reported higher levels of pain in women following surgical extraction of third molars under LA. They concluded that there may be differences in pain tolerance and sensitivity between males and females and that females may be more “accurate” in recording their pain than males. Gender differences in pain reporting may be due to behavioural differences rather than perceptual biological differences [Jones et al., 2003]. Gender-specific report bias as a function of sociocultural factors such as sex of the interviewer, female in the present study, may have resulted in bias. However, the evidence for interviewer’s gender as an influencing factor on pain reported by men and women is equivocal [Feine et al., 1991; Levine and De Simone, 1991].

In the present study, no attempt was made to compare the results for each of the three operators who carried out the ILA and extractions, as over 60% were carried out by one operator only. All the patients were questioned within 2 hours of gaining consciousness post-operatively as pain control during this time is thought to be critical. However, there may be differences between patients’ ability to respond to verbal questionnaires during the early post-GA recovery period, which may also explain the differences between patients’ response to the pain questionnaire.

**Conclusion**

ILA was a safe adjunct for pain control in children having permanent molar extractions under GA. Sixty-three percent of children found the experimental side of the mouth better in terms of pain control. A significantly higher percentage of boys than girls reported ILA to be more effective for post-operative pain control. The majority of children experienced some pain following extraction of first permanent molars under GA. Therefore, future studies are needed to determine predictors of pain in children in order to develop effective individualised pain management strategies for patients having dental extractions under GA.

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**References**


