The influence of two different dental local anaesthetic solutions on the haemodynamic responses of children undergoing restorative dentistry: a randomised, single-blind, split-mouth study

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Objectives This investigation was designed to study the haemodynamic effects of two different local anaesthetic solutions during restorative dental treatment in children.
Design A randomised, single-blind, split-mouth cross-over design was employed using children undergoing bilaterally similar restorative treatments over two visits.
Setting The study was performed in a dental hospital paediatric dentistry department.
Methods Ten children participated. At one visit the local anaesthetic was 2% lidocaine (lignocaine) with 1:80,000 epinephrine (adrenaline); at the other the anaesthetic was 3% prilocaine with 0.03IU/ml felypressin. Local anaesthetic was administered at a dose of 0.5 ml/10 kg body weight. Blood pressure and heart rate were measured before and during treatment with an automatic blood pressure recorder. Data were analysed by ANOVA and Student's paired *t* test.
Results Significant differences between treatments in diastolic blood pressure ($F = 2.37$; $P = 0.05$) and heart rate ($F = 2.98$; $P < 0.02$) were noted. The heart rate increased ten minutes following the injection of the epinephrine-containing solution. The diastolic blood pressure fell 20 minutes after injection of lidocaine with epinephrine.
Conclusion The choice of local anaesthetic solution influences the haemodynamic response during restorative treatment in children.

The influence on the haemodynamic response of vasoconstrictors contained in dental local anaesthetics has been the subject of investigation for many years.[1–3] Most studies have been performed in healthy and medically-compromised adults.[1,4,5] There is little information relating to the effects of different local anaesthetics on the haemodynamic responses of children undergoing dental treatment. The object of this investigation was to study the cardiovascular responses of children undergoing restorative dentistry with two different local anaesthetic solutions which contained different vasoconstrictors.

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Materials and methods

Following the receipt of ethical approval from the joint ethics committee for Newcastle and North Tyneside Health Authority and the University of Newcastle upon Tyne ten children agreed to participate in the study. Written informed consent was obtained from each child's parent. Each child required similar restorative treatment on opposite sides of the jaw and this was performed over two visits. In every respect with the exception of the local anaesthetic used, both visits were similar. The same surgery, operator and nurse were used throughout and all treatments were intracoronal restorations. Treatments were performed 1 week apart. The only difference between visits was the local anaesthetic. On one occasion the local anaesthetic used was 2% lidocaine (lignocaine) with 1:80,000 epinephrine (adrenaline), on the other 3% prilocaine with 0.03 IU/ml felypressin. The order of use of the local anaesthetic was randomised and the child was unaware of which solution was being used at each visit. The volume of local anaesthetic used was adjusted to the patient's weight; a dose of 0.5 ml per 10 kg was injected. An aspirating technique was employed.

The patient was weighed before treatment and 10 minutes before the injection the cuff of an automatic blood pressure recorder was applied to the patient's left arm. Base-line systolic and diastolic blood pressure and heart rate were measured. Blood pressure and heart rate recordings were repeated immediately following and 10, 20 and 30 minutes after injection of the local anaesthetic. Restorative treatment began 5 minutes after the injection. The readings taken immediately at the end of the injection were considered to represent the haemodynamic response to the act of injection and the subsequent readings as a reaction to both the pharmacological effect of the injection and the response to treatment.

Data were analysed by ANOVA and Student's paired *t* test; *P* values ≤ 0.05 were considered significant.

Results

The mean (± standard deviation) age of the patients was 9.0 ± 1.3 years (range 6.5 to 10.5 years) and the mean (± standard deviation) weight was 31.6 ± 12.8 kg. Five patients received lidocaine with epinephrine at the first visit and five received prilocaine with felypressin for their initial treatment. No child required supplementary anaesthesia at any stage of the investigation.

There were no significant differences between base-line recordings between treatment visits (Table 1). Similarly, there were no differences between the readings taken immediately after injection compared with pre-local anaesthetic injection recordings for any parameter measured (Table 1). The changes from pre-injection

Table 1 Base-line recordings before local anaesthetic administered for the ten patients (mean + standard deviation)

Treatment	SBP (mmHg)	DBP (mmHg)	Heart rate (bpm)
Lidocaine with epinephrine	108.8 ± 8.0	68.3 ± 12.7	88.3 ± 6.9
Prilocaine with felypressin	111.7 ± 9.5	63.9 ± 11.0	95.5 ± 12.4

systolic blood pressure did not differ between visits (Fig. 1). However, the changes from base-line recordings at 10, 20 and 30 minutes differed between treatments for both diastolic blood pressure ($F = 2.37$; $P = 0.05$) and heart rate ($F = 2.98$; $P < 0.02$) (Figs 2 and 3). The significant change in diastolic blood pressure occurred 20 minutes after injection where the drop in diastolic pressure following the injection of the epinephrine-containing solution differed from the change occurring after the epinephrine-free solution was used (difference between treatments $t = 2.9$; $P < 0.02$). The mean (± standard deviation) drop in diastolic blood pressure 20 minutes after the administration of lidocaine with epinephrine was 7.7 ± 10.3 mmHg compared with a rise of 2.6 ± 7.7 mmHg at the same time following injection with prilocaine with felypressin (change from base-line after lidocaine with epinephrine $t = 2.37$; $P = 0.042$). The major change in heart rate occurred at 10 minutes, an increase of 5.3 ± 7.9 beats per minute in heart rate occurring after the injection of lidocaine with epinephrine compared to a fall of 4.7 ± 5.6 beats per minute after the injection of prilocaine with felypressin (difference between treatments $t = 3.3$; $P < 0.01$, change from base-line with prilocaine and felypressin $t = 2.65$; $P = 0.026$).

Discussion

Dental local anaesthesia can produce adverse effects caused by both the anaesthetic agent and any vasoconstrictor the solution may contain. The levels of lidocaine following intra-oral anaesthesia in children having treatment under sedation have been investigated.[6]

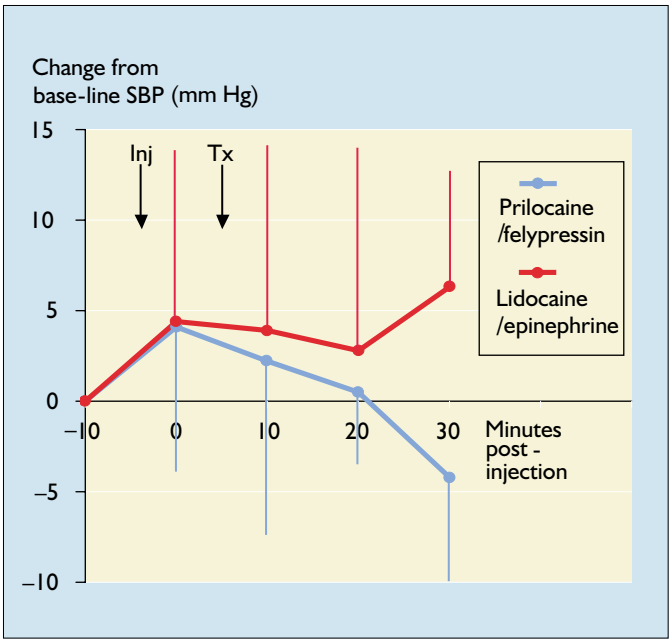

Fig. 1 Change from base-line systolic blood pressure versus time. Time –10 is 10 minutes before the local anaesthetic injection; time 0 is immediately at the end of the injection. The dots are the mean changes and the vertical bars represent one standard deviation for the sample of ten patients. Inj represents the time of injection; Tx represents the time treatment began

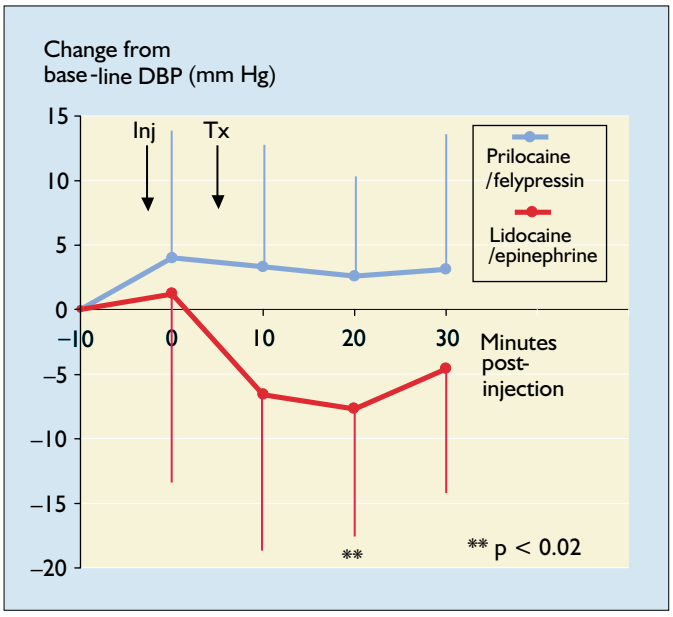

Fig. 2 Change from base-line diastolic blood pressure versus time. Time –10 is 10 minutes before the local anaesthetic injection; time 0 is immediately at the end of the injection. The dots are the mean changes and the vertical bars represent one standard deviation for the sample of ten patients. The asterisks represent significant differences between treatments. Inj represents the time of injection; Tx represents the time treatment began

However, to our knowledge, the haemodynamic effects of different local anaesthetic solutions administered during routine dental treatment under local anaesthesia alone has never been evaluated in children.

Epinephrine is included in dental local anaesthetic formulations to increase the depth and duration of action. In addition, it provides haemostasis for surgical procedures. Epinephrine has a number of haemodynamic effects. Alpha-adrenergic effects lead to peripheral vasoconstriction, beta-adrenergic agonism leads to increased force and rate of contraction of the heart and vasodilatation in muscles. Thus epinephrine increases systolic blood pressure and heart rate and decreases diastolic blood pressure. Despite the fact that epinephrine is a vasoconstrictor its entry into the circulation following intra-oral injection occurs early in the post-injection period.[7] Biochemical changes attributable to exogenous epinephrine are apparent 10 minutes following intra-oral anaesthesia in adults.[4,5]

Studies of blood pressure and heart rate in adult volunteers and in adult patients undergoing oral surgery with the same local anaesthetics used in this investigation have shown no differences in the changes in systolic blood pressure and heart rate but a decrease in diastolic blood pressure following injection of the epinephrine-containing solution.[5,8] The results of the present investigation confirm the changes in diastolic blood pressure found in adults and also show changes in heart rate attributable to the local anaesthetic injection.

Some studies have suggested that stress during intra-oral procedures can exaggerate haemodynamic influences of the local anaesthetic.[9] Other investigations have reported that the use of an epinephrine-containing solution negates any lessening of the sympatho-adrenal response achieved by sedation.[10] The results of this investigation confirm earlier findings that changes attributable to local anaesthesia[11] are not masked by the stresses of dental treatment and that cardiovascular responses are governed by the choice of local anaesthetic. Some believe that epinephrine-containing local anaesthetics produce better anaesthesia and thus reduce the endogenous release of catecholamines.[12,13] However, the changes attributable to an increase in epinephrine reported in this study

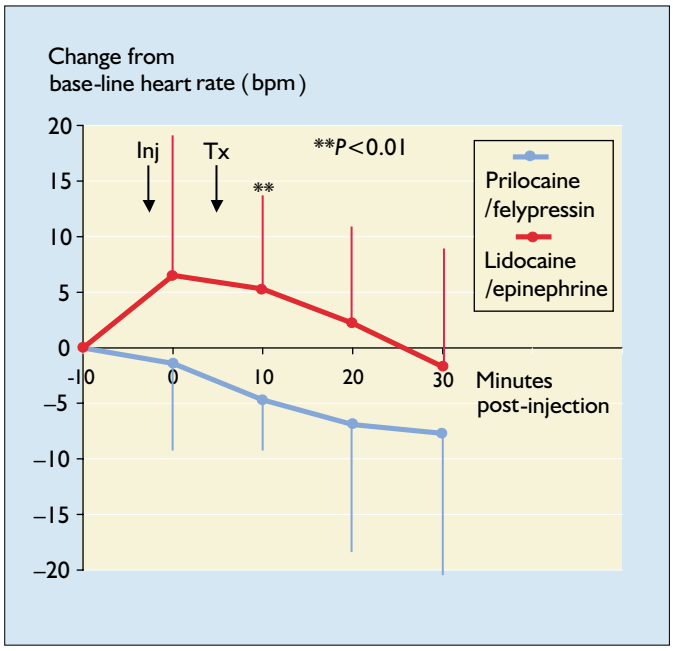

Fig. 3 Change from base-line heart rate versus time. Time –10 is 10 minutes before the local anaesthetic injection; time 0 is immediately at the end of the injection. The dots are the mean changes and the vertical bars represent one standard deviation for the sample of ten patients. The asterisks represent significant differences between treatments. Inj represents the time of injection; Tx represents the time treatment began

(a decrease in diastolic blood pressure and in increase in heart rate), occurred after the injection of the epinephrine-containing solution.

The dose of local anaesthetic used in this investigation was standardised to the weight of the patient and was approximately 25% of the recommended maximum dose. In order to avoid local anaesthetic toxicity the calculation of dose per weight should be considered for all patients, but this is especially the case with children. The recommended maximum dose for lidocaine is 4.4 mg/kg and for prilocaine it is 6.0 mg per kilogram. Local anaesthetic toxicity leading to fatalities can occur in children when doses considered safe in adults are used.[14]

The numbers used in this investigation were small but did detect changes between treatments. The sample size was chosen as studies using this methodology[5,8] had shown changes in adult patients attributable to the choice of local anaesthetic. In addition the design of the present investigation did not ideally isolate the effects of epinephrine as both solutions contained vasoconstrictors. Nevertheless, the design did mimic clinical practice as an epinephrine-free lidocaine solution is not useful for pulpal anaesthesia. Felypressin being a vasoconstrictor, does have haemodynamic effects. However, the doses used in dentistry are very low. In a study investigating the cardiovascular effects of felypressin contained in dental local anaesthetics in hypertensive adult patients[15] no significant haemodynamic changes were attributable to the use of a solution containing felypressin at a dose of 0.03 IU/ml.

The changes reported in this study, although statistically significant, do not represent a hazard in healthy children. Nevertheless, the fact that different local anaesthetics influence the haemodynamic responses in children undergoing dental treatment means that, in young patients with cardiovascular anomalies changes produced by different local anaesthetics might be important. For example it is known that transplanted hearts are supersensitive to catecholamines[16] and significant increases in heart rate attributable to epinephrine in dental local anaesthetic solutions have been demonstrated in adult cardiac transplant recipients.[17] At present there are no recommendations concerning the use of epinephrine-containing local anaesthetics in children with heart transplants. The results of this study suggest that the choice of local anaesthetic in such children merits consideration.

Conclusion

The choice of local anaesthetic influences the haemodynamic response in children undergoing restorative dentistry.

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