

Benefits of transcortical anesthesia in children and adolescents

Summary:

Up to now, transcortical or intraosseous anesthesia has been described in the adult. The objective of this study has been to evaluate the effectiveness of this treatment on 82 children and adolescents, with an average age of 8.1 ± 3.3 years, using Quick Sleeper 2. A total of 126 teeth were treated during 112 sessions. The evaluation could be performed for 105 sessions. The success rate was 92.4% for the sessions (97/105), allowing 110 out of 118 teeth to be treated (93.2%). For deciduous teeth, the overall success rate was 94.4% (67/71), divided into 97.7% (endodontics), 100 % (conservative care) and 83.3 % (extractions). For permanent teeth, it was 91.5% (43/47). On average, 0.45 anesthetic carpules were used. Transcortical anesthesia appears supplemental, or even an alternative, to standard infiltration anesthesia for children and adolescents.

Key words: anesthesia, children, transcortical

INTRODUCTION

Because children differ from adults with regard to physiology, anatomy of the mouth and psychology, intra-oral anesthesia in children may pose special problems. Intra-gingival anesthetics are the standard methods (Vinckier, 2000a; Mortier et al., 2001; Daublander, 2005) that practitioners use most frequently for children (Barbosa-Rogier et al., 2004). They include infiltration and spix anesthetics. They are however accompanied by not insignificant risks of self-biting. Use of the syringe makes the psychological approach difficult and the injection may be accompanied by pain. These latter problems may be resolved in part by an electronic injection aid provided by systems such as The Wand (1), Sleeper One (2) or Comfort Control Syringe (3) (Palm et al., 2004; Oztas et al., 2005). Subperiosteal (intragingival), standard intraosseous (intraosseous) or intrapulpal anesthetics are considered to be supplemental anesthetics (Vinkier, 2000a, 2000b; Mortier et al., 2001). However, they have limitations linked to their aggressivity towards periodontal (intragingival) tissues and the bacteraemia associated with them (intragingival anesthetics: Rogers et al., 1996) or else they are painful (intrapulpal anesthetics). For adults, assisted transcortical (intradiploic) anesthesia may represent an alternative or supplement to these methods (Quinn, 1998; Meechan, 2002, 2005; Kleber, 2003; Forbes, 2005). It is called *intraosseous* in English.

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Author	System	Population (ages)	number	Operations evaluated	% success
Leonard MS(1955)	Stabid	Adults	164	Extractions	Not shown
Dunbar et al. (1996)	Stabid	Adults (18-39)	40	Pulpal vitality test ^b	77-100*
Reisman et al. (1997)	Stabid	Adults (18-55)	33	Endodontics ^b	73-97***
Replogle et al. (1997)	Stabid	Adults (18-39)	42	Pulpal vitality test	41-46*
Nusstein et al. (1998)	Stabid	Adults (19-68)	24	Endodontics (pulpitis)	88
Parente et al. (1998)	Stabid	Adults (> 18 years)	37	Endodontics ^a	89
Reitz et al. (1998)	Stabid	Adults (18-43)	38	Pulpal vitality test ^b	50-100*
Gallatin et al. (2003)	X-Tip Stabid	Adults (19-43 years)	47	Pulpal vitality test	93-95 *
Nusstein et al. (2003)	X-Tip	Adults (2007 years)	33	Endodontics ^b	82
Villette(2003)	Quick S	Adults	529	Extractions Endodontics Conservative Care	96-100**
Nusstein et al. (2005)	Stabid	Adults (19-51 years)	40	Pulpal vitality test	98
Prohic et al. (2005)	Stabid	Adults	25	Extractions	80

Table 1. Prior studies on transcortical anesthetics in adults

Its principle is based on the needle's mechanical passage, with the help of a rotating instrument, through the cortical bone in the interdental area, followed by the injection of the anesthesia solution. Studies published to date on transcortical anesthesia involve adults, basically for endodontic and surgical procedures with the help of X-Tip 4), Stabident (5) and Quick Sleeper 2 (6) systems (Table 1).

These three systems are available in France and are used by a large number of practitioners. X-Tip and Stabident make it possible to make a hole through which an injection is performed using a syringe with an infiltration needle. Quick Sleeper 2 combines both the motor and the system for administering the anesthetic.

The objective of this retrospective study has been the evaluation within a Dental Clinic of the feasibility and effectiveness of transcortical anesthesia in children and adolescents with the Quick Sleeper 2 system.

Equipment and Methods

Population

The children included in the evaluation attended the Pedodontics Unit of the Dental Clinic at Rennes University Hospital. They presented no general pathology, and no infectious risk. Patients showing behavioural problems were also excluded from the study.

All authors used a solution of lidocaine 2% + adrenaline 1/100,000, except for Replogle et al. (mepivacaine 3%), and Villette (articaine 4% + adrenaline 1/100,000)

^a Intraosseous anesthesia used as first-line treatment

^b Intraosseous anesthesia used as a supplement to infiltration anesthesia

* % success according to the location of the teeth tested

** : 96% transcortical anesthesia alone; 100% with supplemental intraligamentary anesthesia

***: 73% with one injection, 97% with 2 injections

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Procedure

All anesthetics were performed by a single operator. The treatments were carried out by this operator or students working in the Unit.

The anesthetic used was articaine hydrochloride 4% combined with adrenaline at 1/200,000 (Alphacaine N (7)). Administration was performed using a 0.40 diameter 12-mm intraseptal needle (Sofijet (8)).

After presenting the system to the children if they were not already familiar with it, the anesthesia consisted of an initial phase of intraconjunctival anesthesia, the needle being placed as parallel as possible to the mucosal surface. This angle of penetration enables a painless injection. Once the mucosa was anesthetised, the actual transcortical anesthesia was performed: rotation of the needle was controlled by a pedal, then the anesthetic solution was injected, also controlled by a pedal. After administering 0.45 ml of the solution (a quarter of a carpule), sensitivity was checked for by gently pressing on the buccal and lingual mucosa of the teeth in question with a mouth spatula. More anesthetic was given transcortically where there was remaining sensitivity, and also if sensitivity appeared during the operation. Where there was persistent sensitivity, a supplemental intraseptal, infiltration or spix anesthesia was performed.

Statistical analysis

The statistical analysis was performed with the EpiInfo version 6.0 software using the chi-squared test and analysis by the exact Fisher test.

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Age

Figure 1. Breakdown of sessions according to the children's age

Results

A total of 112 sessions involving 82 children (37 girls, 45 boys) between 4 and 16 years old (8.1 ± 3.3 years old) were evaluated (Figure 1). Fifty-five sessions concerned maxillary teeth (49.1 %) and 57 mandibular teeth (50.9 %). Sixty-six sessions (58.9 %) involved deciduous teeth only, 41 (36.6 %) permanent teeth, 5 (4.5%) at least one deciduous tooth and one permanent tooth at the same time. In 19 cases (17%, average age 7.1 ± 2.9 years old) the transcortical anesthesia was performed on a patient benefiting from conscious sedation with the help of an equimolecular mixture of oxygen and nitrous oxide (EMONO). The operations involved 126 teeth, including, for deciduous teeth, endodontic treatments (48), repair treatments (11) and extractions (20). Repair operations were the most frequent for permanent teeth (33, including 11 direct pulpal/subpulpal) followed by extractions (8) and endodontic treatments (6).

The principal results over the total population are summarised in table 2. Intracortical penetration was always obtained after a single needle rotation period (2.69 seconds). The average quantity of anesthetic solution injected was 0.80 ± 0.28 ml, which was 0.45 of

a carpule on average. Treatments and extractions were possible in 97 cases (86.6%). In 85/97 sessions, a single operation was performed, two operations on 11 others, and three on one child.

The behaviour of seven children, 6.3% of the population, made it impossible to evaluate the effectiveness of the anesthesia: panic attacks, treatment refused, etc. This category only included children 10 years old and less (four in the 4-5 year old band) and concerned six sessions on deciduous teeth and one on one deciduous tooth and one permanent tooth.

When the patients who could not be evaluated are not taken into account, the success rate is 92.4% (97/105 sessions). The breakdown of failures (8/105; 7.6 %) is given in table 3.

The success rate by type of operation is shown in table 4. When only cases that could be evaluated are analysed, the overall success rate per tooth treated is 93.2% (110/118).

Results	Total (number)	Total (%)
Complete lack of sensitivity	87	77.7
Treatment can be carried out despite slight sensitivity or supplemented by painless intraseptal anesthesia	10	8.9
Failures	8	7.1
Cannot be interpreted	7	6.3
Total sessions (126 teeth)	112	100

Table 3. Characteristics of failures

Age	Sex	Operation	Comments
5	B	Extraction / 85 bone infected, absorbed	
6	G	Extraction / 55 bone infected, absorbed	
6	G	Extraction / 83 bone infected, absorbed	Child very fearful, not willing
8	G	Pulpotomy repeated / 55	Child very fearful. Tooth painful for several days
8	B	Care for hypoplastic 36	Tooth sensitive to food, difficult to reach the injection site
13	B	Extraction 34 (for dentofacial orthopedics)	Extreme anxiety from the beginning
13	G	Extraction 24 (for dentofacial orthopedics)	Extreme anxiety from the beginning
15	B	Care for 46	Care under conscious sedation for phobia to anesthesia

Table 2. Characteristics and effectiveness of anesthetics performed

Operation	Success	Failure	ND	Total
Deciduous teeth				
Endodontics	42	1	5	48
Conservative care	10	0	1	11
Extractions	15	3	2	20
Total deciduous teeth	67	4	8	79
Permanent teeth				
Endodontics	6	0	0	6
Conservative care	31	2	0	33
Extractions	6	2	0	8
Total permanent teeth	43	4	0	47

The results apply to 126 operations attempted in 112 sessions.

ND: effectiveness impossible to determine because of the child's behaviour.

Table 4. Result frequency by operation carried out.

For deciduous teeth, the rate is 94.4% (67/71), broken down into 97.7% (endodontics: 42/43), 100% (conservative care: 10/10) and 83.3% (extractions: 15/18). For permanent teeth, the rate is 91.5% (43/47) broken down into 100% (endodontics: 6/6), 93.9% (conservative care: 31/33) and 75% (extractions: 6/8).

Statistically, there is no difference in the breakdown of cases that could/could not be evaluated ($p > 0.05$) whatever the age group compared. No difference in success/failure rate according to age could be shown ($p > 0.05$) whatever the age-bands compared.

For patients benefiting from conscious sedation, one case could not be evaluated. For the 18 remaining sessions, the success rate was 94.4% (17/18); the only failure was a patient showing a phobia to anesthesia.

A slight anesthesia at the mucosa was noticed in eight cases (7.1 %). In each case, it involved anesthesia administered to the mandible (the Vincent sign). No post-anesthesia pain was reported during patient follow-up sessions, nor was any post-anesthesia mucosal lesion noticed or reported. No case of self-biting of the mucosa was noted.

DISCUSSION

Evaluating an anesthesia system in young subjects has to overcome with a number of problems:

- difficulty of psychological approach: fear that is unreasonable and too strong, panic attacks, difficulty of getting a message across to the very young, changes in behaviour among adolescents
- difficulty of evaluating pain with certain children
- technical feasibility, because the small size of the mouth cavity means access to certain zones is not possible
- legal feasibility, because few molecules have marketing authorisation for children under 4 years old

The results of this retrospective study, and the 6.3 % of sessions that could not be interpreted, must therefore be analysed in this context. Added to this there are the characteristics of transcortical anesthesia, and Quick Sleeper 2 in particular. Not looking like a syringe is a significant help and, for the very young, the "magic pen" is reassuring. The very great ease of penetration into the bone of a child (a single sequence of rotating the needle) is also an advantage. On the other hand, despite preparing children psychologically, the vibrations of the needle's rotation phase may be a disagreeable surprise to them and influence their view of the anesthesia.

The population studied, with an average age of 8.1 years, was made up of children and adolescents attending a unit in a hospital. The very youngest, those with a handicap, an illness or a behavioural problem were not included in this retrospective study. The population can therefore be compared to the population attending a general practice.

The success rate of 92.4% (sessions) or 93.2% (teeth) is comparable to the results usually described. In a review of the documentation, Vinckier (2000b) cited a 7 to 10% failure with oral injection anesthesia. The anesthetics grouped together under the term intraosseous in general give comparable results, with the success rate varying between 41 and 100% (Table 1). These studies were all carried out for adults, and some of them involved vitality tests on teeth free of pathologies, not therapeutic operations (Dunbar et al., 1996; Replogle et al., 1997; Reitz et al., 1998; Gallatin et al., 2003; Nusstein et al., 2005), which does not make it possible to gauge real sensitivity during an operation such as extraction of an infected tooth or endodontics on a tooth with inflamed pulp. Most of the work published indicates that several sequences of needle rotation may be needed. In the study by Villette (2003) indicating 96% success, the author states that on average 2.1 (upper jaw) and 3.26 (mandible) sequences of needle rotation were necessary to perform the injection. All the injections in this study were performed after a single sequence of needle rotation. The smaller bone density in children explains why only one sequence was needed. The previous studies were carried out using an anesthetic (most often lidocaine 2%) combined with adrenaline at a 1/100,000 concentration, which has a greater effect than 1/200,000 concentration used in our study. Using a greater concentration of adrenaline may make it possible to solve certain difficulties or to reduce the dose administered. However, changing to a higher concentration is still disputed for the very youngest subjects. This discussion involves all vasoconstrictors anyway.

According to the authors, these are not recommended below 4 years old (Mortier et al, 2001) or 6 months (Madrid et al., 2003). A number of studies show there is no problem when the combination of articaine and adrenaline is used with children, even those under 4 years old (Wright et al., 1989, 1991; Malamed, 2000). The recommended quantity for the child for local anesthesia would be 1mL.kg^{-1} for a 1/200,000 concentration in the anesthetic solution (Bennaceur, 2001). Other studies are clearly necessary concerning this.

This retrospective study is the first to analyse the effectiveness of transcortical anesthesia on children, involving deciduous teeth in particular. The effectiveness is obtained, except for the children who could not be evaluated, in almost all cases of conservative care and endodontics (52/53, or 98.1 %) with a quantity of anesthesia corresponding to less than a half carpule, and the lack of gingival anesthesia and the risk of biting the mucosa. The attraction of transcortical anesthesia is enormous in this type of treatment. The success rate is smaller in the case of extractions of deciduous teeth (83.3 %). This might be explained by two phenomena. 1) In most cases, it concerns children with a difficult relationship to teeth and dentists, seen as linked to pain 2) The teeth to be taken out are usually in an inflamed and infected area in which the bone is completely or partly absorbed. In these situations, it can be difficult to concentrate the anesthetic product in the area concerned. In other words: without bone, it is difficult to be intraosseous.

This study involved fewer permanent teeth. It is difficult to draw conclusions from the eight teeth extracted and the six teeth studied for endodontics treatment. In two cases of endodontics, however, transcortical anesthesia was used on molars when the standard intra-gingival anesthesia was unsuccessful. The success obtained in all cases of direct pulpal or subpulpal capping should be combined (11 cases). These results confirm those obtained in adults for endodontic operations. The success rate for conservative treatments (31/33; 93.9%) is comparable to those obtained in adults (table 1) or with different anesthesia methods (Vinckier, 2000b).

• Conclusion

This retrospective study shows a success rate for transcortical anesthesia in children and adolescents of above 90 %, with easier implementation than in adults (a single needle rotation sequence) probably linked to the lower bone density in young subjects. For deciduous teeth, the best success rates were obtained with repair treatments (100%) and endodontics (98 %). No undesirable effect on the mucosa or bone was noted, nor any case of self-biting. Transcortical anesthesia appears

supplemental, or even an alternative, to standard infiltration anesthesia for children and adolescents. Other studies are needed to further improve its effectiveness, widen its field of application and evaluate the way young patients feel about it.

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