

Local anaesthetic for post-tonsillectomy pain: a systematic review and meta-analysis

Grainger, J. & Saravanappa, N.

Department of Otorhinolaryngology, University Hospital of North Staffordshire, Stoke-on-Trent, UK

Accepted for publication 29 July 2008

Clin. Otolaryngol. 2008, **33**, 411–419

Background: Tonsillectomy is one of the most commonly performed procedures in otolaryngology. Pain is a significant aspect of post-operative patient morbidity. The use of local anaesthetic, by infiltration or topical application, has been advocated as a way of reducing post-operative pain.

Objectives: To review the current evidence for the use of local anaesthetic as a means of reducing post-tonsillectomy pain and reducing supplemental analgesic requirements.

Type of review: A systematic review of the literature pertaining to the use of local anaesthetic agents for post-tonsillectomy pain and meta-analysis of randomised control trials assessing pain scores.

Search strategy: Systematic literature searches of MEDLINE (1952–2008), EMBASE (1974–2008) and the Cochrane Central Register of Controlled Trials.

Evaluation method: Review of all randomised controlled trials by two authors and grading of articles for quality.

Results: Thirteen studies were included. Overall, local anaesthetic, applied topically or infiltrated, significantly reduces pain scores compared with controls at 4–6 h, -0.66 (95% CI: $-0.82, -0.50$); 20–24 h, -0.34 (95% CI: $-0.51, -0.18$) and on day 5, -0.97 (95% CI: $-1.30, -0.63$) (standardised mean differences). These changes approximate to a reduction in pain of between 7 and 19 mm on a 0–100 mm visual analogue scale. Most studies did not report a difference in supplemental analgesia or in adverse events.

Conclusion: Local anaesthetic does seem to provide a modest reduction in post-tonsillectomy pain. Topical local anaesthetic on swabs appears to provide a similar level of analgesia to that of infiltration without the potential adverse effects and should be the method of choice for providing additional post-operative analgesia.

Tonsillectomy is one of the most frequently performed procedures in general otolaryngology practice. In 2005–2006, over 50 000 tonsillectomies were performed in England and Wales, most for recurrent tonsillitis.¹ Pain following tonsillectomy is well recognised and a significant cause of patient morbidity. Post-operative pain may result in poor oral intake and possibly an increased risk of secondary haemorrhage. Furthermore, the increase in daycase tonsillectomy has further increased the need to improve analgesia in the post-operative period.

In order to reduce post-tonsillectomy pain, a number of strategies have been developed by anaesthetic and surgical staff including the use of corticosteroids, alteration of anaesthetic and surgical technique and the use of local anaesthetic agents.² The use of local anaesthetic agents, either by topical application into the tonsillar fossa, or by

infiltration either before or after tonsillectomy has been studied as a method of reducing post-tonsillectomy pain.^{2–14}

The rationale behind the use of local anaesthetic agents in the peri-operative period relates not only to its ability to block peripheral nociceptor transmission after tissue damage but also in preventing sensitisation of the central nervous system. Experimental studies have suggested that peripheral tissue damage produces changes in neuronal excitability, resulting in reduced pain thresholds and hypersensitivity to nociceptive stimuli. These changes may outlast the actual nociceptive stimulus and may be prevented by local anaesthetic agents prior to tissue damage.^{15,16}

A systematic review of the literature in 1999 concluded that there was no evidence that the use of peri-operative local anaesthetic agents improved post-operative pain control following tonsillectomy.¹⁷ However, this review was based on a small number of studies and did not include any studies published after 1997. Since this time there have been a number of other high-quality studies published in the literature.

Correspondence: Joe Grainger, Department of Otorhinolaryngology, University Hospital of North Staffordshire, A34, Newcastle Road, Stoke-on-Trent ST4 7LN, UK. Tel.: +44 1782 715444; fax: +44 1782 552895; e-mail: joe.grainger@btinternet.com

© 2008 The Authors

Journal compilation © 2008 Blackwell Publishing Ltd • *Clinical Otolaryngology* **33**, 411–419

This systematic review provides updated information on the use of per-operative local anaesthetic agents as a method of reducing post-tonsillectomy pain.

Objectives

- 1 To assess the efficacy of local anaesthetic, applied topically or injected locally, in reducing both early and late post-tonsillectomy pain.
- 2 To determine if the use of topical or injected local anaesthetic reduces the need for post-operative analgesia.
- 3 To assess the safety of local anaesthetic infiltration and topical application.

Methods

Search strategy

We searched MEDLINE (1952–2008), EMBASE (1974–2008) and the Cochrane Central Register of Controlled Trials for English language articles. A highly sensitive search strategy for randomised controlled trials developed by the Cochrane collaboration¹⁸ was combined with the term TONSIL* to search MEDLINE. The term TONSIL\$ was used in EMBASE and the results limited to CLINICAL TRIAL. The initial results were reviewed by the first author (JG) and any relevant articles were then reviewed in full.

Study selection

All randomised controlled trials of local anaesthetic for post-tonsillectomy pain were reviewed in full by both authors independently. The selection of studies for inclusion in the review was based on the criteria below.

Participants. Adults and children undergoing tonsillectomy by any surgical technique were included. Studies that analysed patients undergoing additional procedures, for example adenoidectomy, were excluded. Studies not employing a standardised anaesthetic protocol were also excluded.

Intervention. The following studies were included:

- 1 Injection of local anaesthetic solution into the tonsillar region prior to tonsillectomy.
- 2 Injection of local anaesthetic into the tonsillar region following tonsillectomy.
- 3 Topical application of local anaesthetic using swabs to the tonsillar fossa following tonsillectomy.

Quality assessment. The selected studies were assessed independently for methodological quality by each author.

Differences in opinion were resolved by discussion. The method of quality assessment used was based on the previous systematic review by Hollis *et al.*¹⁷ Each study was graded A, B or C based on the following criteria; adequate randomisation, group size greater than 10 patients, intention to treat analysis and less than 20% lost to follow-up, blinding of outcome assessors and a validated outcome assessment for pain. Studies graded 'A' were required to fulfil all criteria. Those partially meeting one or more criteria were graded 'B' and those not meeting one or more criteria were graded 'C'. Studies graded 'A' were included in the review.

Data collection and analysis

Primary endpoints. The primary endpoints used were resting pain scores at 4–6, 20–24 h and five days post-operatively. Where pain score was measured at multiple points during the outcome intervals, the pain scores at the time closest to six and 24 h were used. In studies where multiple local anaesthetics were compared against a single placebo group and vice versa, a combined treatment effect was calculated. This method avoids counting individual subjects twice and introducing a unit-of-analysis error.¹⁸

Secondary endpoints. Secondary endpoints were the amount of additional post-operative analgesia used and adverse events.

Analysis. Data from the included studies was extracted by the first author (JG). Data analysis was performed using dedicated meta-analysis software [REVIEW MANAGER (REVMAN), version 5.0. Copenhagen: the Nordic Cochrane Centre, The Cochrane Collaboration, 2008]. Standardised mean differences (SMD) and 95% confidence intervals (CI) were calculated using a fixed effect model. Standardised mean differences allow the combining of continuous data where different measurement tools have been used to assess the outcome of interest. This measure provides a qualitative measure of effect but may be transformed back to a more clinically relevant value by multiplying it with a typical standard deviation of the instrument of interest.¹⁹

Results

Search results

The initial searches of MEDLINE and EMBASE revealed 1370 and 1464 studies, respectively. Following the

removal of duplicates and review of the titles and abstracts, 46 potential studies were identified and reviewed in full by the authors. No studies were identified from the CENTRAL database. Non-randomised controlled trials, trials without pain as an outcome measure, studies investigating topical spray application and those including subjects undergoing adenoidectomy were excluded. In addition, a single study of local anaesthetic tonsillectomy was excluded. Following quality assessment, 13 studies were graded 'A' and included in the final analysis. Five studies were graded 'B' and seven studies graded 'C'. The characteristics of included studies can be found in Table 1. Nine of the studies included in the analysis were published following the 1997 systematic review.¹⁷ Of the included studies most allocated individual patients to intervention or control arms.^{2-8,10,11,13,14} Two studies^{9,12} used an 'intra-individual study design' where one side received the intervention and the contra-lateral side the control. A variety of local anaesthetic agents and concentrations were used in the included studies, thus precluding meaningful meta-analysis of individual agents. The addition of epinephrine to both local anaesthetic agents and control agents was also variable. Approximately half of the included studies looked at the effects of local anaesthetic for post-tonsillectomy pain in children only.

Pain at 4–6 h

Two of the 13 included studies did not provide sufficient data during the early post-operative period for inclusion in the meta-analysis.^{11,12} Overall, compared with placebo, local anaesthetic resulted in a standardised mean difference (SMD) in pain score at 4–6 h of -0.66 (95% CI: $-0.82, 0.50$; Fig. 1). One study² used a validated pain scale based on observation of expression and distress and another⁹ used the contra-lateral side as the control arm. Subgroup analysis excluding these studies did not significantly alter the overall findings.

Subgroup analysis by method of application suggested that topical application of local anaesthetic agents provided a better reduction in pain score than infiltration techniques, although the results were not significantly different (Fig. 1). A sensitivity analysis, performed by the inclusion of lower quality studies, graded 'B' and 'C', again demonstrated an SMD in pain score of -0.63 (95% CI: $-0.75, -0.52$) with local anaesthetic.

Pain at 20–24 h

Only one study did not provide sufficient data at 20–24 h for inclusion in the meta-analysis.¹¹ Overall, compared with placebo, local anaesthetic, resulted in an

standardised mean difference (SMD) in pain score at 20–24 h of -0.34 (95% CI: $-0.51, -0.18$; Fig. 2). Removal of studies using the contra-lateral tonsillar fossa as control or the study using observer pain scores rendered this reduction in pain score non-significant.

Subgroup analysis by method of application did demonstrate an SMD in pain score for subjects receiving topical local anaesthetic compared with controls of -1.91 (95% CI: $-2.67, -1.16$); however, this finding was based on a single small study and should be interpreted with caution. Sensitivity analysis using excluded studies was not significantly different from the primary outcome.

Pain on day 5

Only three studies assessed pain scores on day 5 post-tonsillectomy. Overall, compared with placebo, local anaesthetic resulted in a standardised mean difference (SMD) in pain score on day 5 of -0.97 (95% CI: $-1.30, -0.63$; Fig. 3). Subgroup analysis by method of application did not reveal any significant differences between infiltration and topical application and sensitivity analysis using excluded studies did not alter the overall outcome.

Additional analgesia requirements

Most studies reported finding no difference in supplemental analgesia requirements between the local anaesthetic and control groups. One study did not record additional analgesia usage¹⁴ and two used standardised post-operative analgesia protocols.^{5,8} Three studies^{2,7,10} reported significantly lower additional analgesia usage in patients receiving local anaesthetic. These studies were all paediatric studies and all reported significantly lower pain scores in the intervention groups also. No studies demonstrated significantly higher analgesia usage in the control groups.

Adverse events

Where post-operative complications were assessed, most studies found no differences in adverse events between control and intervention groups. Only Sorenson *et al.* reported a significantly higher rate of intra-operative blood loss from the control side during tonsillectomy and a higher rate of secondary haemorrhage from the control side.

One patient who received local anaesthetic infiltration in the study by Bell *et al.*³ developed cervical osteomyelitis and died 8 weeks post-operatively. The relevance of this to the intervention is not clear, but the authors suggested caution if further trials were to be carried out.²⁰

Table 1. Characteristics of included studies

Study	Participants	Method of randomisation	Intervention/control (tonsillectomy method)	Outcomes
Akoglu <i>et al.</i> , 2006 ²	46 children; age range: 2–12 years	Random allocation by computer-generated numbers	Int: pre-op infiltration 0.25% bupivacaine or 0.2% ropivacaine Con: saline infiltration (Cold dissection/ligatures)	mCHEOPS pain score Adverse effects Time to first analgesia Post-op analgesia Mean arterial BP HR Pain score (VAS) at 2, 6 and 24 h post-op
Arcioni <i>et al.</i> , 1995 ¹⁴	20 children; age range: 5–10 years	Random allocation by computer-generated numbers	Int: pre-op infiltration 1% lidocaine with 0.125% bupivacaine Con: nil (Not stated)	Pain score (VAS) at rest at 12 h and days 1, 2, 5 and 10 post-op Pain score (VAS) on drinking at 12 h and days 1, 2, 5 and 10 Operating time Blood loss Otagia Complications
Arikan <i>et al.</i> , 2006 ^{*12}	25 adults	Central randomisation by hospital pharmacy	Int: pre-op infiltration 0.2% ropivacaine with 1 : 200 000 adrenaline Con: infiltration with adrenaline only (Cold dissection/bipolar)	Pain score (VAS) at rest at 10 min, 4 h, and 24 h post-op Pain score (VAS) on swallow at 10 min, 4 h and 24 h post-op
Bell <i>et al.</i> , 1997 ³	78 adults	Randomisation by sealed envelope	Int: pre-op 'glossopharyngeal nerve block' with 0.5% bupivacaine with 1 : 200 000 adrenaline by anaesthetist Con: nil (Dissection/diathermy/ligatures)	Pain score (VAS) on drinking on days 2–6 Pain score (0–6) at rest at 4, 6, 8 h and 24 h post-op Post-op analgesia usage BP and HR Complications
El-Hakim <i>et al.</i> , 2000 ⁴	92 adults	Randomisation by computer-generated numbers	Int: pre-op 'glossopharyngeal' and 'lesser palatine' nerve blocks with 0.5% bupivacaine Con: saline infiltration or nil (Bipolar dissection and haemostasis)	Pain score (VAS) at 1, 3 and 6 h post-op Time to first eat and drink Post-op analgesia usage Complications
Hung <i>et al.</i> , 2002 ⁵	99 children; age range: 3–16 years	Randomisation by sealed envelope	Int: topical 0.5% bupivacaine on swabs applied for 5 min Con: saline swabs (Bipolar dissection and haemostasis)	Pain score (VAS) at 1, 5, 9, 13, 17 and 21 h post-op Pain score (VAS) at rest and on swallow at 36 h Post-op analgesia usage Categorical sedation score
Molliex <i>et al.</i> , 1996 ⁶	68 adults and children; age range: 8–65 years	Randomised by sealed envelope	Int: pre- or post-op infiltration 0.25% bupivacaine with 1 : 200 000 adrenaline Con: pre-op saline infiltration (Electrocautery)	

Table 1. Continued

Study	Participants	Method of randomisation	Intervention/control (tonsillectomy method)	Outcomes
Naja <i>et al.</i> , 2005 ⁷	90 children; age range: 5–12 years	Randomised by sealed envelopes	Int: pre-op infiltration 2% lidocaine with 1 : 200 000 adrenaline, 0.5% bupivacaine, fentanyl and clonidine mix Con: saline infiltration or nil (Cold dissection/electrocautery/electrocautery haemostasis)	BP, HR, SpO ₂ Pain score (VAS) at rest, on jaw opening and eating at 0, 6 and 12 h post-op and on days 2–10 Surgeon satisfaction Post-op analgesia usage Complications Pain score (VAS) at 1, 5, 13, 17, 21 and 24 h and days 2–6 post-op
Oghan <i>et al.</i> , 2008 ⁸	41 children; age range: 4–16 years	Randomised by computer-generated numbers	Int: topical 1% ropivacaine on swabs applied for 5 min Con: topical saline on swabs (Cold dissection/swab haemostasis)	Pain score (VAS) at rest and drinking at 4 h and days 1, 2, 3 and 8 post-op Additional analgesia usage
Orntoft <i>et al.</i> , 1994 ¹³	36 adults	Randomised using coded numbers and sealed envelopes	Int: pre- or post-op infiltration 0.25% bupivacaine Con: pre-op saline infiltration (Cold dissection/haemostasis not stated)	HR Blood loss Dissection time Pain score (VAS) at 3–8 h and day 2 Pain score (VAS) at 1, 5, 10, 15, 30 and 60 min post-op and at 2, 6, 12 and 24 h Sedation score Additional analgesia usage Pain score (VAS) at 15 min, 1, 4, 12, 16 and 24 h Additional analgesia usage Duration of admission Antiemetic usage
Sorensen <i>et al.</i> , 2003 ⁹	52 adults	Randomised by sealed envelopes	Int: Pre-op infiltration 1% lidocaine with 1 : 200 000 adrenaline Con: nil	
Unal <i>et al.</i> , 2007 ¹⁰	60 children; age range: 4–17 years	Randomised by sealed envelopes	(Cold dissection/bipolar haemostasis) Con: pre-op infiltration 0.25% bupivacaine or 0.2% ropivacaine with 1 : 200 000 adrenaline Int: saline with adrenaline infiltration (Electrocautery)	
Vasan <i>et al.</i> , 2002 ¹¹	70 adults	Randomised by sealed envelopes	Int: pre-op infiltration 0.5% bupivacaine Con: saline infiltration (Cold dissection/ligatures)	

*Intra-individual study design.

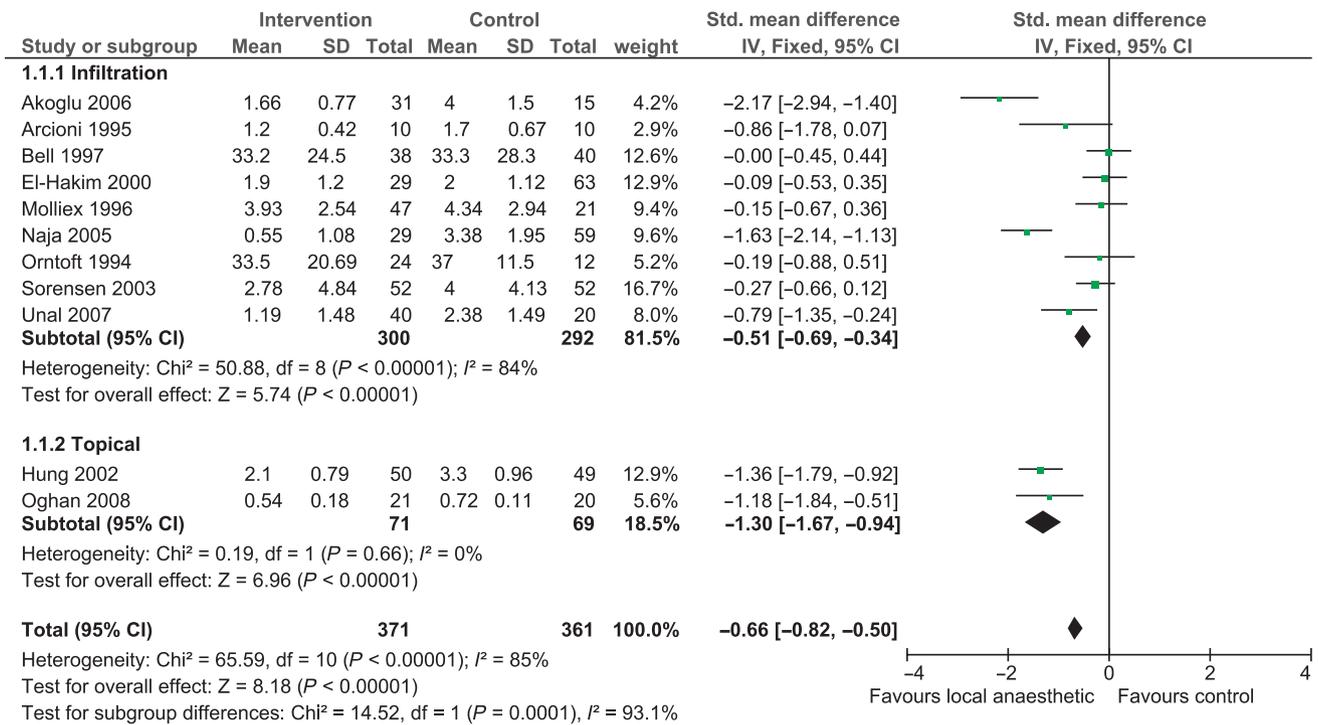


Fig. 1. Pain scores 4–6 h post-tonsillectomy.

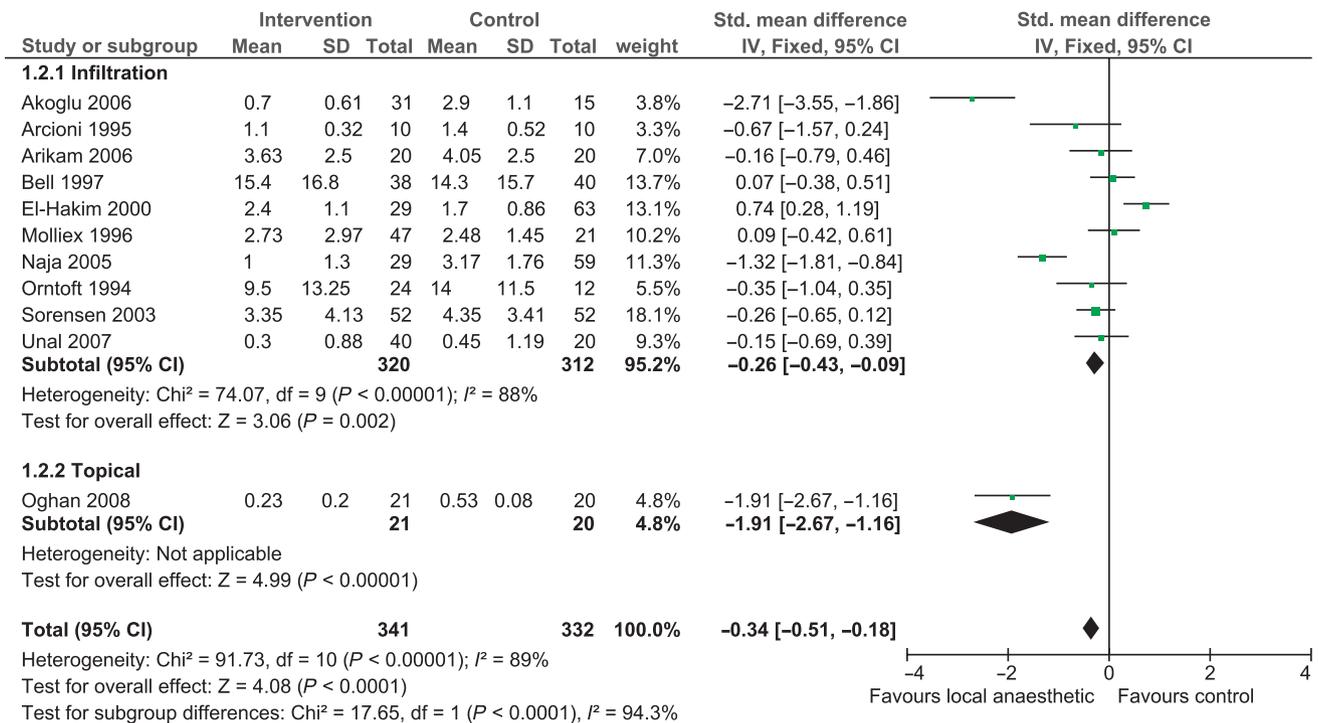


Fig. 2. Pain scores 20–24 h post-tonsillectomy.

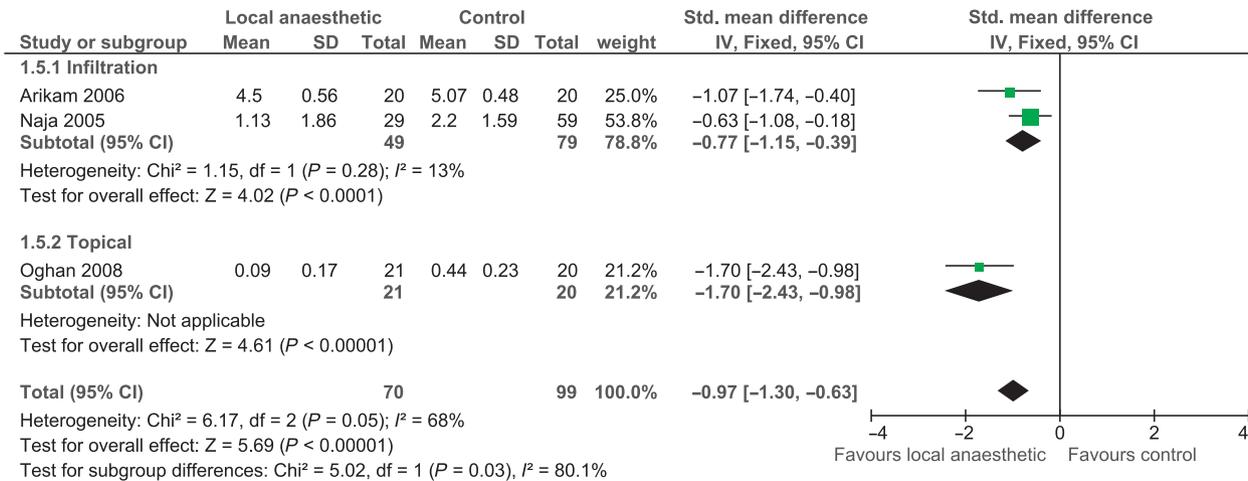


Fig. 3. Pain scores on day 5.

Discussion

Summary of results

Overall, the published evidence suggests that local anaesthetic does reduce resting post-tonsillectomy pain when infiltrated or applied topically. Whilst the reduction in pain scores is statistically significant at 4–6, 20–24 h and days 5 post-tonsillectomy, the clinical significance of this difference is less certain. At 4–6 and 20–24 h, this effect is ‘moderate’ using the rule of thumb for standardised mean differences.¹⁸ Back transformation of the standardised mean differences for the three time periods yields a reduction in pain scores of 13, 7 and 19 mm on a 0–100 mm visual analogue scale, based on a typical standard deviation of 20 mm. However, clinical quantification of standardised mean differences can be misleading and these values must be treated with caution given the difficulty in determining a typical standard deviation.¹⁹ The reduction in resting pain with local anaesthesia does not appear to translate to a reduction in the use of supplemental analgesia with the exception of three studies where patients receiving local anaesthetic required less analgesia.^{2,7,10} The potential reasons for this are outlined below.

Quality of evidence

The quality of the evidence in the included studies was high. All of the included studies used validated pain scales and subjects were randomised by an accepted method. Most studies allocated subjects to either intervention or control arms. Two studies did use an ‘intra-individual’ design with one tonsillar fossa receiving the intervention and the contra-lateral side receiving the control.^{9,12} Exclu-

sion of these studies in the analysis did not alter the overall outcome. However, we feel that whilst the design reduces confounding factors it has a number of drawbacks including difficulty in assessing which side the pain is from, problems with cross contamination and issues with blinding.

Heterogeneity

There is certainly significant statistical heterogeneity demonstrated in the meta-analysis. The methodological characteristics of the studies are very homogenous and the statistical heterogeneity demonstrated probably results from clinical diversity. The included trials have significant variation in the type of local anaesthesia, whether epinephrine was used and when the local anaesthetic was infiltrated or for how long it was applied. Furthermore, the use of different validated pain scales may have contributed to the statistical diversity, although the use of standardised mean differences does reduce this variation.

Whilst these variations preclude any meaningful meta-analysis of individual agents, we believe they do not preclude evaluation of local anaesthetics as a class of drugs for post-tonsillectomy analgesia.

Completeness and applicability of evidence

Subjects included in the studies were typical of those seen in routine otolaryngology practice, with a mix of paediatric and adult patients. The studies in the analysis only included subjects undergoing tonsillectomy – those undergoing additional procedures, for example adenoidectomy, were excluded. The local anaesthetic preparations were only applied to the tonsillar region; therefore, pain

from a different location may have masked any reduction in pain in the intervention group. We accept that the inclusion of English language articles only may have introduced some bias into the review. However, this has been demonstrated not to significantly alter the outcome of meta-analyses of medical interventions.^{9,21}

The timing of the pain scores used for analysis were set arbitrarily to represent pain early in the post-tonsillectomy period when local anaesthetic agents may still be expected to be working and later in the post-tonsillectomy period after which they may be expected to have no residual effect. The findings from the analysis suggest that even after 20 h when most agents have no residual anaesthetic effect there remains a moderate reduction in pain score. Furthermore, there appears to be a persisting analgesic effect on day 5. This finding does lend some support to the 'pre-emptive analgesia' theory, which suggests that local anaesthesia may reduce sensitisation of the dorsal horn neurons, leading to a prolonged reduction in post-operative pain.^{15,16} However, proponents of this theory believe that this sensitisation occurs at the time of injury under general anaesthetic and suggest that post-operative infiltration or application is not as effective as pre-incisional infiltration.²² This does not seem to be supported by the limited number of studies applying topical local anaesthesia.

The use of supplemental analgesia in the post-tonsillectomy period is a complicating factor in the design of studies investigating local anaesthetic for post-tonsillectomy pain. Given the modest effect the local anaesthetic may have, it is possible that even small differences in post-operative analgesia consumption may mask some of the local anaesthetic effect. These differences may not be statistically detectable. Furthermore, it is difficult to compare with accuracy the effect of different analgesic agents in order to allow valid comparison. Although the included studies measured pain prior to the administration of supplemental analgesia, there may have been some residual analgesic effect on subsequent measurements.

The included studies were generally relatively small with the largest study studying only 104 subjects.⁹ The ability of these studies to detect adverse events is poor and this needs to be considered when assessing the clinical applicability of an intervention. The post-operative haemorrhage rate does not appear to be different when local anaesthetic is used. However, two studies did raise significant concerns about more severe complications. In the study by Bell *et al.*³ there was a reported fatal case of osteomyelitis 8 weeks post-tonsillectomy in their intervention group and the authors raise concerns about local anaesthetic injection in the tonsillar region.²⁰ During the course of the review, an

interrupted randomised controlled trial was identified.²³ In this trial, two subjects had developed life-threatening upper airway obstruction as a result of local anaesthetic infiltration and vocal cord paresis. A number of other case reports exist within the literature highlighting complications relating to local anaesthetic infiltration for post-tonsillectomy pain. These include Horner's syndrome,²⁴ facial nerve paralysis²⁵ and atlanto-axial subluxation from osteomyelitis.²⁶

Conclusions

Implications for practice

Overall, local anaesthetic does seem to provide a modest reduction in post-tonsillectomy pain. However, the method of application should be carefully considered given the uncommon but potentially serious adverse events associated with infiltration of local anaesthetic into the tonsillar region through potentially infected tissue. Topical local anaesthetic on swabs appears to provide a similar level of analgesia to that of infiltration without the potential adverse effects and should be the method of choice for providing additional post-operative analgesia.

Implications for research

There is a need for further research in this area. A multi-centre randomised controlled trial is needed to provide further evidence with statistical strength. Further research should clearly separate tonsillectomy from adenotonsillectomy, use standardised anaesthetic protocols, validated outcome tools and standard post-operative analgesia protocols.

Keypoints

- Pain following tonsillectomy is a significant cause of post-operative morbidity.
- This systematic review outlines the evidence for the use of peri-operative local anaesthetic agents in reducing pain following tonsillectomy.
- The evidence suggests that local anaesthetic infiltrated or applied topically to the tonsillar fossa significantly reduces post-tonsillectomy pain.
- This effect may last beyond the duration of action of the local anaesthetic agent.
- Topical application of local anaesthetic to the tonsillar fossa may be a safer method of application than infiltration.

Conflict of interest

None to declare.

References

- Department of Health. Hospital Episode Statistics 2005–2006. <http://www.hesonline.nhs.uk> 2008
- Akoglu E., Akkurt B.C., Inanoglu K. *et al.* (2006) Ropivacaine compared to bupivacaine for post-tonsillectomy pain relief in children: a randomized controlled study. *Int. J. Pediatr. Otorhinolaryngol.* **70**, 1169–1173
- Bell K.R., Cyna A.M., Lawler K.M. *et al.* (1997) The effect of glossopharyngeal nerve block on pain after elective adult tonsillectomy and uvulopalatoplasty. *Anaesthesia* **52**, 597–602
- El-Hakim H., Nunez D.A., Saleh H.A. *et al.* (2000) A randomised controlled trial of the effect of regional nerve blocks on immediate post-tonsillectomy pain in adult patients. *Clin. Otolaryngol. Allied Sci.* **25**, 413–417
- Hung T., Moore-Gillon V., Hern J. *et al.* (2002) Topical bupivacaine in paediatric day-case tonsillectomy: a prospective randomized controlled trial. *J. Laryngol. Otol.* **116**, 33–36
- Molliex S., Haond P., Baylot D. *et al.* (1996) Effect of pre- vs postoperative tonsillar infiltration with local anesthetics on postoperative pain after tonsillectomy. *Acta Anaesthesiol. Scand.* **40**, 1210–1215
- Naja M.Z., El-Rajab M., Kabalan W. *et al.* (2005) Pre-incisional infiltration for pediatric tonsillectomy: a randomized double-blind clinical trial. *Int. J. Pediatr. Otorhinolaryngol.* **69**, 1333–1341
- Oghan F., Harputluoglu U., Guclu E. *et al.* (2008) Does topical ropivacaine reduce the post-tonsillectomy morbidity in pediatric patients? *Int. J. Pediatr. Otorhinolaryngol.* **72**, 361–365
- Sorensen W.T., Wagner N., Aarup A.T. *et al.* (2003) Beneficial effect of low-dose peritonsillar injection of lidocaine–adrenaline before tonsillectomy. A placebo-controlled clinical trial. *Auris Nasus Larynx* **30**, 159–162
- Unal Y., Pampal K., Korkmaz S. *et al.* (2007) Comparison of bupivacaine and ropivacaine on postoperative pain after tonsillectomy in paediatric patients. *Int. J. Pediatr. Otorhinolaryngol.* **71**, 83–87
- Vasan N.R., Stevenson S. & Ward M. (2002) Preincisional bupivacaine in posttonsillectomy pain relief: a randomized prospective study. *Arch. Otolaryngol. Head Neck Surg.* **128**, 145–149
- Arikan O.K., Ozcan S., Kazkayasi M. *et al.* (2006) Preincisional infiltration of tonsils with ropivacaine in post-tonsillectomy pain relief: double-blind, randomized, placebo-controlled intraindividual study. *J. Otolaryngol.* **35**, 167–172
- Orntoft S., Longreen A., Moiniche S. *et al.* (1994) A comparison of pre- and postoperative tonsillar infiltration with bupivacaine on pain after tonsillectomy. A pre-emptive effect?. *Anaesthesia* **49**, 151–154
- Arcioni R., Cannata F., Bandiera G. *et al.* (1995) Post-operative pain control through peritonsillar local anaesthetic infiltration in children undergoing tonsillectomy. *Acta Anaesth. Italica* **46** (Suppl. 1), 29–34
- Wall P.D. (1988) The prevention of postoperative pain. *Pain* **33**, 289–290
- Woolf C.J. (1983) Evidence for a central component of post-injury pain hypersensitivity. *Nature* **306**, 686–688
- Hollis L.J., Burton M.J. & Millar J.M. (1999) Perioperative local anaesthesia for reducing pain following tonsillectomy. *Cochrane Database Syst. Rev.* **4**, CD001874.
- Higgins J.P.T. & Green S. (2008) *Cochrane Handbook for Systematic Reviews of Interventions*, 5th edn. The Cochrane Collaboration.
- Scholten R.J., de B.E. & Bouter L.M. (1999) From effect size into number needed to treat. *Lancet* **354**, 598
- Cyna A.M., Bell K.R. & Flood L.M. (1997) Cervical osteomyelitis following tonsillectomy. *Anaesthesia* **52**, 1084–1087
- Moher D., Pham B., Lawson M.L. *et al.* (2003) The inclusion of reports of randomised trials published in languages other than English in systematic reviews. *Health Technol. Assess.* **7**, 1–90
- Ejlersen E., Andersen H.B., Eliassen K. *et al.* (1992) A comparison between preincisional and postincisional lidocaine infiltration and postoperative pain. *Anesth. Analg.* **74**, 495–498
- Bean-Lijewski J.D. (1997) Glossopharyngeal nerve block for pain relief after pediatric tonsillectomy: retrospective analysis and two cases of life-threatening upper airway obstruction from an interrupted trial. *Anesth. Analg.* **84**, 1232–1238
- Hobson J.C., Malla J.V. & Kay N.J. (2006) Horner's syndrome following tonsillectomy. *J. Laryngol. Otol.* **120**, 800–801
- Shlizerman L. & Ashkenazi D. (2005) Peripheral facial nerve paralysis after peritonsillar infiltration of bupivacaine: a case report. *Am. J. Otolaryngol.* **26**, 406–407
- Sipila P., Palva A., Sorri M. *et al.* (1981) Atlantoaxial subluxation. An unusual complication after local anesthesia for tonsillectomy. *Arch Otolaryngol.* **107**, 181–182

Copyright of *Clinical Otolaryngology* is the property of Blackwell Publishing Limited and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.