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Main Article

Blood splash from different diathermy instruments during tonsillectomy

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Abstract

Objective: To compare the potential risk of blood contamination of the surgeon's conjunctiva during tonsillectomy using disposable bipolar diathermy and reusable monopolar diathermy.

Design: A prospective, single-blind, randomized, controlled trial.

Methods: Elective tonsillectomy was performed using either disposable bipolar diathermy or reusable monopolar diathermy. The operating surgeon wore a Viewsafe™ protective eyeshield which was later examined under an operating microscope by a blinded observer and the number of blood spots counted.

Results: One hundred and sixty-eight patients were enrolled. The relative risk of conjunctival contamination of the surgeon using disposable bipolar diathermy was 2.8 times that with reusable monopolar diathermy (chi-squared test, $p < 0.0005$). A previous history of peritonsillar abscess and additional adenoidectomy were associated with increased blood splatter.

Conclusion: The use of disposable bipolar diathermy for haemostasis during tonsillectomy poses a greater risk of conjunctival contamination for the surgeon than using reusable monopolar diathermy.

Key words: Tonsillectomy; Blood; Conjunctiva; Electrocoagulation; Diathermy

Introduction

In January 2001, to decrease the possible risk of person-to-person transmission of variant Creutzfeldt–Jakob disease via contaminated surgical instruments during adenoidectomy and tonsillectomy, the UK Department of Health instructed the health service to use disposable instruments for these operations. The sudden cessation in the use of the old instruments created a scramble to obtain disposable ones. This was followed by reports of increased risk to patient safety from the new instruments. Disposable mouth gags were reported to have become entangled with the anaesthetist's endotracheal tube,[1] and there was a rise in the incidence of post-operative haemorrhage in cases in which disposable electrodiathermy had been used.[2] In December 2001, reusable instruments were reintroduced for tonsil surgery. However, disposable instruments continued to be used in Northern Ireland.[3]

By 2003, Antrim Area Hospital (Northern Ireland) was using a combination of single use disposable bipolar diathermy and reusable monopolar diathermy for haemostasis during tonsillectomy (disposable monopolar diathermy was not obtainable from the hospital's supplier). There were anecdotal reports from staff that there appeared to be a greater incidence of blood splatter events with the disposable bipolar diathermy compared with the monopolar diathermy. Hepatitis B, hepatitis C and human immunodeficiency virus are all transmissible by inoculation of the conjunctiva by contaminated blood.[4–6] Three previous reports have demonstrated a real risk of conjunctival contamination of the surgeon during tonsillectomy.[7–9] The possible effect of different diathermy instruments on this risk has not been addressed.

The following study was performed to determine if there was a greater potential for contamination of the surgeon's conjunctiva with patients' blood when using disposable bipolar diathermy compared with reusable monopolar diathermy.

Materials and methods

Null hypothesis

The null hypothesis for the study was that the risk of conjunctival contamination of the surgeon with a patient's blood during tonsillectomy using disposable bipolar diathermy for haemostasis would be the same as that when using reusable monopolar diathermy.

Participants

Adult and paediatric patients undergoing elective tonsillectomy who had no known history of a

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bleeding disorder were eligible for inclusion in the study. Any additional procedures performed were recorded. Local ethical committee approval was obtained. Surgeons eligible for participation were those with more than six months' ENT operating experience. Operations took place in the Antrim Area Hospital, a district general hospital.

Randomization

Patient consent for enrolment in the study was requested at a pre-admission clinic. On admission to hospital, randomization was performed by an ENT secretary using random numbers generated on a scientific calculator (Texet^{TM} Albert4 fraction scientific calculator, Texet, Manchester, England). Each patient was assigned a sequential study number at the point of randomization. The secretary kept a list of the study numbers, hospital unit numbers and which type of diathermy was used. The operating theatre was informed of the type of diathermy instrument required for each patient.

Intervention

Tonsillectomy was performed with cold steel dissection and haemostasis was secured using reusable monopolar diathermy (Eschmann fingerswitch electrode handle with 100 mm blade, Eschmann, Lancing, West Sussex, England) or disposable bipolar diathermy (Kirwan 200 mm disposable non-stick bipolar forceps with 1.5 mm tip, Kirwan, Marshfield, Massachusetts, USA). Additional suture ligation (ties) was used at the surgeon's discretion provided this was documented. All surgeons wore a Viewsafe^{TM} eyeshield (Medisafe, Sumatra, Indonesia), which consisted of a reusable frame and a detachable plastic visor. The visor was placed in a plastic envelope at the end of the operation and labelled with the patient's study number. The diathermy machine setting was entered in the patient's notes.

Sample size

The risk of conjunctival contamination with reusable monopolar diathermy was estimated to be 0.4 and the risk with disposable bipolar diathermy was estimated to be 0.6. This was based on the results of a study by Kelly *et al.* which found that 46 per cent of visors examined using an operating microscope after tonsillectomy with bipolar diathermy were contaminated with blood.[9] If a p value of less than 0.05 was considered necessary to reject the null hypothesis, then a sample size of 400 would be required in order for the study to have a power of 0.9.

Outcomes

Visors were examined using an operating microscope under $\times 6$ magnification. The visors were positioned under the microscope using a custom-made wooden jig with a white surface. The jig moved in a set pattern so that the entire surface of the visor could be scanned without repetition. The number of blood spots was counted. The first 40 visors were examined by two observers to ensure counting agreement. Contamination of the visor which did not look typical of a blood droplet was checked by a pathologist under a high power microscope. The observers were blinded as to the type of diathermy used.

Statistical methods

Results were analysed using the SPSS version 11 statistical software package. Logistic regression was performed for confounding variables.

Results and analysis

Recruitment and participant flow

The study stopped after enrolment of 168 patients, because procurement of disposable bipolar diathermy instruments by the hospital trust ceased. No patient had declined to participate in the study. Visors from all 168 tonsillectomies were available for analysis. The study ran from July to October 2004.

Baseline data

The 168 patients enrolled were randomized to two groups. Eighty-four patients were randomized to undergo tonsillectomy performed with disposable bipolar diathermy and 84 with reusable monopolar diathermy. In the disposable bipolar group, 44 patients were female and 40 were male. Forty-five patients were children (age range, two to four years; mean, 7.6 years) and 39 patients were adults (age range, 15–43 years; mean, 24.3 years). In the reusable monopolar group, 46 patients were female and 38 male. Forty-six patients were children (age range, three to 14 years; mean, 6.6 years) and 38 were adults (age range, 15–34 years; mean, 20.6 years).

Nine surgeons participated in the study. They comprised three consultants, two specialist registrars, a staff grade and three senior house officers. All had more than six months' ENT operating experience and performed tonsillectomies without assistance.

The indications for tonsillectomy were categorized as recurrent infections, previous peritonsillar abscess and indications other than infection. The last category included sleep apnoea, halitosis, dysphagia or mouth breathing or snoring, and asymmetrically enlarged tonsils. For the purposes of this study, a history of one peritonsillar abscess proven by the finding of pus led to categorization as 'previous peritonsillar abscess', even if the surgeon operated because the main complaint was recurring sore throat. The number of patients in each category is shown in Table I.

Thirty-one patients underwent additional procedures. Twenty children underwent adenoidectomy, 14 underwent myringotomy and ventilator insertion, and five children underwent both procedures. One child underwent fine needle aspiration of a lymph node and one child underwent submucosal diathermy of the inferior turbinates.

Ties were used in 75 (45 per cent of total) cases. Forty of these cases were in the disposable bipolar diathermy group and 35 were in the reusable monopolar diathermy group.

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TABLE I

CATEGORIZATION OF INDICATIONS FOR TONSILLECTOMY

Category	Indication	Disposable bipolar diathermy group (*n*)	Reusable monopolar diathermy group (*n*)
1	Sleep apnoea	2	1
	Halitosis	0	1
	Asymmetrical tonsils	1	1
	Dysphagia, mouth breathing or snoring	1	1
2	Recurrent infection	78	79
3	Previous peritonsillar abscess	2	1

TABLE II

VARIABLES AFFECTING OUTCOME

Predictor of outcome	Visors uncontaminated with blood [*n* (%)]	Visors contaminated with blood [*n* (%)]
All variables combined	107 (63.7)	61 (36.3)
Indication 1	6 (75)	2 (25)
Indication 2	100 (63.7)	57 (36.3)
Indication 3	1 (33.3)	2 (66.7)
Surgeon 2	12 (42.9)	16 (57.1)
Surgeon 4	5 (45.5)	6 (54.5)
Additional adenoidectomy	7 (46.7)	8 (53.3)

A diathermy machine setting of 35 W was used for all but five of the tonsillectomies performed with reusable monopolar diathermy for haemostasis. A setting of 25 W was used in two cases and a setting of 30 W was used in three cases. A range of diathermy machine settings from 10 to 25 W was used in conjunction with the disposable bipolar diathermy.

Outcome

Of the 168 visors available for analysis, 61 (36 per cent) were contaminated with blood. Forty-five of the visors used during the 84 tonsillectomies with disposable bipolar diathermy were contaminated, compared with 16 of the visors worn during tonsillectomy with reusable monopolar diathermy. The relative risk of conjunctival contamination of the surgeon during tonsillectomy with disposable bipolar diathermy was therefore 2.8 (95 per cent confidence intervals (CIs), 1.73–4.56) times the risk with reusable monopolar diathermy ($p < 0.0005$, chi-squared). This relative risk was equivalent to an odds ratio of 4.9 (95 per cent CI, 2.5–9.8). Since the relative risk was much greater than that expected when calculating the original sample size, stopping the study early did not have an impact on the statistical significance of the results.

Ancillary analyses

Patient sex, age (adult or child) and the use of ties were not independent predictors of outcome. However, the indication for tonsillectomy, the individual surgeon and additional procedures were associated with a trend toward increased blood contamination of the visors, although this trend was not statistically significant (Table II). Indications for tonsillectomy not related to infections were associated with a decreased rate of blood contamination, whereas previous peritonsillar abscess was associated with a greater rate of blood contamination. Two of the surgeons (both consultants) were associated with a greater occurrence of blood contamination of the visor. The addition of adenoidectomy was associated with increased contamination of the visor. Logistic regression analysis for these variables (indication, surgeon and adenoidectomy) gave an odds ratio of 6.1 (95 per cent CI, 2.8–13.5).

Blood contamination of visors worn during tonsillectomy with disposable bipolar diathermy was more severe as well as more frequent. Twenty-eight droplets of blood were found on the 16 visors contaminated during tonsillectomy with reusable monopolar diathermy (range, one to five drops; mean, two drops) compared with 422 droplets on the 45 visors contaminated during tonsillectomy with disposable bipolar diathermy (range, one to 45 drops; mean, nine drops). A non-parametric Spearman's rank correlation test showed no correlation between the diathermy machine setting and the degree of contamination of the visors used with disposable bipolar diathermy.

Adverse events

A primary haemorrhage occurred in one child treated with monopolar diathermy. Three patients treated with monopolar diathermy and three treated with bipolar diathermy were readmitted with a secondary haemorrhage. One patient treated with monopolar diathermy was readmitted for pain control.

Discussion

Tonsillectomy with disposable bipolar diathermy was associated with increased frequency and severity of blood contamination of visors worn by the surgeon, compared with that performed with reusable monopolar diathermy. This reflects an increased potential for conjunctival contamination of the surgeon, which is statistically highly significant. A history of peritonsillar abscess, the addition of adenoidectomy and individual differences in the surgeons were also associated with an increased likelihood of blood contamination. Although these factors were not found to be statistically significant, they did behave as confounding factors.

Three previous studies have examined blood splashes during tonsillectomy. In two of these studies, the risk of conjunctival contamination of the surgeon was assessed by counting visible blood

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spots on goggles or safety spectacles.[7,8] The rates of blood contamination were 15 and 22 per cent, respectively. The first study included 108 tonsillectomies and found that using ties, as opposed to bipolar diathermy, for haemostasis resulted in a decreased risk of conjunctival contamination. There was no randomization or blinding. In the second study, 46 paediatric and 57 adult tonsillectomies were performed. A statistically significant increased risk of potential conjunctival contamination was found to occur in adult tonsillectomies ($p < 0.05$, Fisher exact test). Again, this study was not randomized or blinded.

In the third study, by Kelly *et al.*, the occurrence of potential conjunctival contamination was assessed by examining under $\times 6$ magnification visors from 100 tonsillectomies.[9] Overall, 46 per cent of visors were contaminated with blood. Haemostasis had been performed with bipolar diathermy in these cases. Logistic regression on the variables demonstrated a difference between some surgeons, but patients' age and the addition of adenoidectomy did not influence the risk of conjunctival contamination.

This present study is the largest investigation to date of the potential for conjunctival contamination of the surgeon during tonsillectomy. The identification of blood was aided by magnification, the observer was blinded to the operative details, and the impact of different diathermy instruments was assessed by randomization. The increased risk of potential conjunctival contamination with disposable bipolar diathermy is significant. The thermal effects of electrocoagulation on tissue, including vaporization, have previously been demonstrated.[10] In the authors' opinion, the concentration of energy between the poles of the bipolar diathermy forceps leads to vaporization of some blood, with consequent splatter of surrounding blood. When using monopolar diathermy, the patient acts as the earth for the active electrode. The patient provides a larger surface area for dissipation of energy than the inactive pole of the bipolar forceps. Thus, vaporization of blood and subsequent splash events are less likely to occur. Although variations in the design of particular forceps (e.g. reusable *vs* disposable, tip width) may produce variation in the amount of blood splatter, it is likely that a difference in blood splash incidents between monopolar and bipolar will still be evident due to their different principles of operation. Indeed, the study by Kelly *et al.*, using bipolar diathermy, was performed prior to the introduction of disposable tonsillectomy instruments. The contamination rate of visors in that study (46 per cent) was similar to the contamination rate of visors used with disposable bipolar diathermy in this study (54 per cent). It is therefore the authors' opinion that the results of this study can be generalized to most forms of monopolar and bipolar diathermy haemostasis used in tonsillectomy.

The interim report of the national audit of tonsillectomy in the UK found an increased incidence of adverse patient events with some forms of tonsillectomy, including those using monopolar diathermy.[11] Just as it is important to determine the risks of different surgical procedures for patients, it is also important for surgeons to know the risks they themselves are exposed to. Although Keogh *et al.*[8] published their results eight years after Prior *et al.*[7] first drew attention to the risk of conjunctival contamination of the surgeon during tonsillectomy, none of the ENT surgeons surveyed by Keogh *et al.* routinely wore eye protection during tonsillectomy, other than spectacles. Attention therefore needs to continue to be drawn to the risk of conjunctival contamination during tonsillectomy, and surgeons should be aware of which procedures or instruments place them at greater risk.

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- **Conjunctival contamination of the surgeon with patient's blood is a risk associated with tonsillectomy**
- **Previous studies of this risk did not examine the impact of different types of diathermy**
- **By means of a single-blinded, randomized, controlled trial, this study demonstrates an increased risk associated with bipolar diathermy, compared with monopolar diathermy, which is statistically highly significant**

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