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MAIN ARTICLE

Cost analysis of injection laryngoplasty performed under local anaesthesia versus general anaesthesia: an Australian perspective

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Abstract

Objective: To conduct a cost analysis of injection laryngoplasty performed in the operating theatre under local anaesthesia and general anaesthesia.

Methods: The retrospective study included patients who had undergone injection laryngoplasty as day cases between July 2013 and March 2016. Cost data were obtained, along with patient demographics, anaesthetic details, type of injectant, American Society of Anesthesiologists score, length of stay, total operating theatre time and surgeon procedure time.

Results: A total of 20 cases (general anaesthesia = 6, local anaesthesia = 14) were included in the cost analysis. The mean total cost under general anaesthesia (AU$2865.96 ± 756.29) was significantly higher than that under local anaesthesia (AU$1731.61 ± 290.29) ($p < 0.001$). The mean operating theatre time, surgeon procedure time and length of stay were all significantly lower under local anaesthesia compared to general anaesthesia. Time variables such as operating theatre time and length of stay were the most significant predictors of the total costs.

Conclusion: Procedures performed under local anaesthesia in the operating theatre are associated with shorter operating theatre time and length of stay in the hospital, and provide significant cost savings. Further savings could be achieved if local anaesthesia procedures were performed in the office setting.

Key words: Laryngoplasty; Office Surgery; Hyaluronic Acid; Vocal Cord Paralysis

Introduction

Recent advancements in technology have enabled some laryngological procedures to be performed in the office using local anaesthesia (LA), rather than in operating theatres under general anaesthesia (GA).[1,2] Current evidence indicates comparable clinical outcomes and complication rates for procedures such as injection laryngoplasty and oesophagoscopy that are performed in-office under LA and in the operating theatre using GA.[1–5] A study recently conducted in Australia showed similar voice outcomes with low complication rates for injection laryngoplasty performed under both anaesthetic modalities.[6] Despite comparable outcomes, major advantages of injection laryngoplasty under LA are the ability to titrate the amount of injection material and procedural precision when injecting into the vocal fold, as the patient is able to phonate during the procedure.[7] Other reported advantages of injection laryngoplasty under LA include low morbidity rates, reduced recovery time, and a quicker return to family and work-related activities.[8] However, not all injectates can be administered under LA, as fat injection requires fat harvest, which is performed under GA.

There is increasing pressure for healthcare services to ensure good clinical outcomes and minimise costs.[9] Recent studies conducted in the USA on patients who underwent injection laryngoplasty have reported significant cost savings of in-office procedures using LA compared to in-theatre procedures that require GA.[5,10] This was largely because of resources such as pre-admission clinics, operating theatres, operating theatre staffing costs, post-operative monitoring and anaesthetic medications that are not required when the procedure is performed in-office.[5]

In Australia, office-based injection laryngoplasty is not routinely performed in the majority of centres, and is offered in only a few subspecialty practices. There is limited research comparing the costs of laryngological procedures performed under GA versus LA within the Australian healthcare system. Therefore, this study

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aimed to evaluate the cost of injection laryngoplasty conducted in the operating theatre under LA versus GA in an Australian tertiary public teaching hospital.

Materials and methods

This retrospective study was approved by the Southern Adelaide Clinical Human Research Ethics Committee (approval number 311.14). The study included patients who underwent injection laryngoplasty for vocal fold paralysis performed as a day-case procedure at Flinders Medical Centre between July 2013 and March 2016. Cases were identified from the electronic operating theatre record system (Operating Room Management Information System ('ORMIS')) and hospital database (Open Architecture Clinical Information System ('OACIS')) using International Classification of Diseases 10th edition codes. Patients who underwent more than one concurrent procedure and those with a documented allergic reaction to LA were excluded. Cases where the primary reason for admission was not an injection laryngoplasty were also excluded, as the actual costs of an injection laryngoplasty could not be isolated from the total costs of the admission.

Data collected included: patient demographics, diagnosis, type of procedure, American Society of Anesthesiologists score, length of stay in hospital, type of anaesthesia (GA *vs* LA), injection material, operating theatre time (from the time patient enters the operating theatre to the time the patient exits the operating theatre) and surgeon procedure time (procedure start time to procedure end time).

All procedures were performed in the operating theatre, regardless of the mode of anaesthesia. The equipment for performing laryngeal procedures (Olympus® Visera Elite and ENF-VH video rhinolaryngoscopes) is currently located in the operating theatre in our hospital. The procedures performed under LA were carried out via a transcutaneous submucosal approach; the GA procedures were performed via a transoral approach. These techniques have been described in other publications.[3,11–15]

The Flinders Medical Centre finance department provided the cost data for all patients in this cohort using the Power Performance Manager software (PowerHealth Solutions, Adelaide, Australia). This software is used as a state-wide costing system and has been implemented throughout all metropolitan hospitals in South Australia. This system links patient activity and inputs to the general ledger expenses, and accurately records the exact cost for each patient encounter. Patient activity includes in-patient admissions, out-patient clinic appointments and presentations to the emergency department. Inputs include pathology, radiology, medication, nursing and medical staff, and all associated overheads. Costing data included: ward costs (medical, nursing and supplies), operating theatre costs (theatre nursing, surgeon, anaesthetic), allied health, depreciation, oncosts (overhead expenditures), hotel and non-clinical costs. The cost of 'hotel' services represents cost per bed day, and includes services such as cleaning, laundry, food and hospital orderlies. Cost variables were further defined as direct costs (directly linked to the patient) and indirect costs (costs that cannot be linked to the patient). Indirect costs include administration, medical personnel and equipment maintenance costs. All cost values were measured in Australian dollars.

Comparison of the cost variables and baseline characteristics between the LA and GA procedures was performed with two-sample independent *t*-tests and chi-square tests. Cost data and time factors were expressed as means ± standard deviations. Multiple linear regression analysis was conducted to estimate the influence of patient factors (age, American Society of Anesthesiologists score, anaesthesia type, injection material type) and time factors (operating theatre time, procedure time and length of stay) on the total cost. A p value of less than 0.05 was considered significant. SPSS statistical software, version 22.0 (SPSS, Chicago, Illinois, USA), was used for all analyses.

Results

Demographics

Twenty injection laryngoplasties that met the inclusion criteria were performed within the study period. A total of 6 procedures were performed under GA and 14 under LA. There was a significant difference in the distribution of males and females between the groups (Table I). Restylane™ and Perlane™ (hyaluronic acid fillers) were used in 16 and 4 patients, respectively. The median American Society of Anesthesiologists scores were similar (scores of 2) for injection laryngoplasty under both anaesthetic modalities. There was no significant difference in patient age between the GA and LA groups (Table I).

Procedure and theatre time, and length of stay

All injection laryngoplasties were performed as day cases, with the mean length of stay for LA procedures

TABLE I
PATIENT CHARACTERISTICS, INJECTION MATERIAL AND ASA SCORE

Parameter	GA group	LA group	p
Age (mean ± SD; years)	56.5 ± 28.2	65.9 ± 16.6	0.36*
Gender (*n* (%))			0.02†
– Male	2 (33.3)	12 (85.7)	
– Female	4 (66.7)	2 (14.3)	
Injection material (*n* (%))			0.82†
– Restylane	5 (83.3)	11 (78.6)	
– Perlane	1 (16.7)	3 (21.4)	
ASA score (*n*)			0.91†
– 1	1	3	
– 2	3	6	
– 3	2	4	
– 4	0	1	

Twenty injection laryngoplasties were performed (6 laryngoplasties in the general anaesthesia group and 14 in the local anaesthesia group). *t-test; †chi-square test. ASA = American Society of Anesthesiologists; GA = general anaesthesia; LA = local anaesthesia; SD = standard deviation

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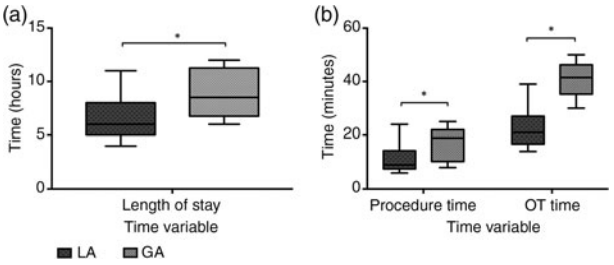

FIG. 1

Comparison of (a) average length of stay and (b) operating theatre (OT) time and procedure time across general anaesthesia (GA) and local anaesthesia (LA) groups. $^{*}p < 0.05$ (*t*-test)

(6.4 ± 1.90 hours) being significantly lower than for GA procedures (8.8 ± 2.48 hours) ($p = 0.025$; Figure 1a). The mean surgeon procedure time under LA (10.86 ± 5.48 minutes) was significantly lower than that under GA (17.17 ± 6.43 minutes) ($p < 0.001$; Figure 1b). The total operating theatre time under LA was also lower (23.07 ± 7.38 minutes) compared to that under GA (40.83 ± 7.03 minutes) ($p = 0.037$; Figure 1b).

Costing analysis

Overall, the mean total cost under GA (AU$2865.96 ± 756.29) was significantly higher than that under LA (AU$1731.61 ± 290.29) ($p < 0.001$; Figure 2). The cost difference between the two anaesthetic modality groups was AU$1134.34, representing a cost saving of 40 per cent for LA. The major contributing factors to the cost difference were the direct and indirect operating theatre costs. Both direct and indirect operating theatre costs were significantly higher under GA, with a difference in mean costs of AU$678.08 and AU$132.79, respectively (Figure 2). The other associated costs, such as non-clinical expenses, cost of ward services, pharmaceuticals and allied health services during admission, were not significantly different between the LA and GA groups (Figure 3).

Multiple linear regression models were used to predict changes in total costs using patient factors and time variables (Table II). The regression model, excluding time as a factor, indicated that the type of anaesthesia was a significant predictor of the total cost ($R^2 = 0.65$, F (19) = 5.27; $p = 0.006$). This model predicted a cost saving of AU$935.83 (standard error = AU$278.62, $t = -3.36$; $p = 0.005$) when injection laryngoplasty was performed under LA. However, when time factors were included, the structure of the linear model changed significantly ($R^2 = 0.88$, F (19) = 20.94; $p < 0.001$). Time spent in the operating theatre became the most significant predictor ($t = 5.96$; $p < 0.001$), followed by length of stay. This model also demonstrated that a 1 minute increase in operating theatre time would result in approximately a AU$43.08 increase in total cost (standard error = AU$6.94, $t = 26.43$; $p < 0.001$). The R^2 value for the model with time predictors is greater than that for the model without time included. This relates to the extra time required for a patient undergoing GA, microlaryngoscopy and patient setup. Therefore, operating theatre time and length of stay are better predictors of the total cost as they are significant factors between the two anaesthetic modality groups undergoing injection laryngoplasty. Model diagnostics were performed and no assumptions appeared to be violated. Hence, both models were valid in predicting the total cost of the operation.

Discussion

Healthcare systems worldwide are currently challenged by the demands of clinical efficacy and cost effectiveness of medical treatment. In this study, we reviewed the activity-based cost analysis of injection laryngoplasty, an increasingly common procedure performed in our centre. This study demonstrates significant savings of 40 per cent when the procedure is performed

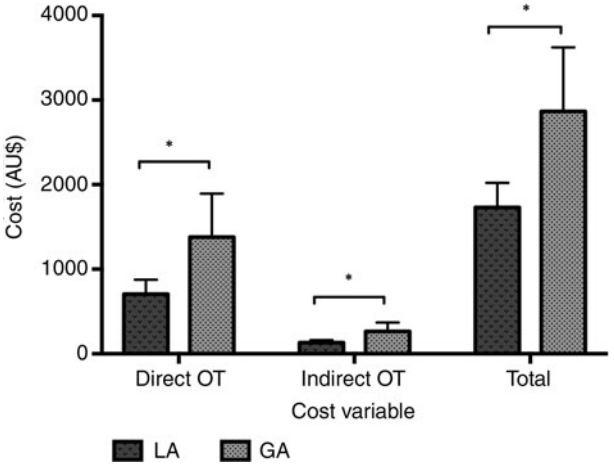

FIG. 2

Comparison of the overall total costs, and direct and indirect operating theatre (OT) costs, across general anaesthesia (GA) and local anaesthesia (LA) groups. $^{*}p < 0.05$ (*t*-test)

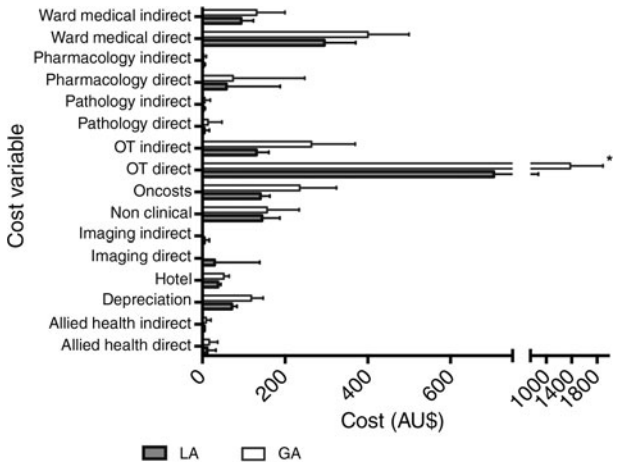

FIG. 3

Comparison of cost variables across general anaesthesia (GA) and local anaesthesia (LA) groups. $^{*}p < 0.05$ (*t*-test). OT = operating theatre

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TABLE II
LOGISTIC REGRESSION ANALYSIS OF PREDICTIVE FACTORS

Models & predictors	Beta coefficient ± SE	Test statistic	95% CI	*p*
Model without time factors*				
– (Constant)	4583.44 ± 863.31	5.31	2731.82, 6435.07	0.00
– Anaesthesia type	−935.83 ± 285.12	−3.36	−1553.42, −338.24	0.01
– Injection material	26.34 ± 285.12	0.08	−630.27, 682.95	0.93
– Patient age (years)	1.90 ± 7.32	0.26	−13.81, 17.61	0.80
– ASA score	−190.56 ± 159.76	−1.19	−533.22, 152.09	0.25
Model with time factors†				
– (Constant)	983.35 ± 628.54	0.628	−364.74, 2331.44	0.14
– Length of stay (hours)	97.66 ± 39.46	2.48	−5.48, 173.30	0.02
– Operating theatre time (minutes)	43.08 ± 8.40	5.13	26.43, 56.18	0.00

*$R^2 = 0.65$, analysis of variance (F) = 5.27 (degrees of freedom = 19). †$R^2 = 0.88$, analysis of variance (F) = 20.94 (degrees of freedom = 19). SE = standard error; CI = confidence interval; ASA = American Society of Anesthesiologists

in the operating theatre under LA compared to GA, with major contributors to the total costs being direct and indirect operating theatre costs.

The total operating theatre time was also shown to be approximately 50 per cent shorter when performed under LA compared to GA. This can be explained by the time taken for patient transfer, positioning, induction, and intubation and extubation. It does not include time spent in pre-operation clinics, day of surgery admission, holding bay or post-anaesthetic care unit. The surgeon procedure time in LA cases was also significantly shorter, as injection laryngoplasty under LA does not require equipment such as the suspension laryngoscope and microscope to be set up prior to the injection, unlike in GA cases. The shorter length of hospital stay for injection laryngoplasty conducted under LA compared to when performed under GA could be largely because of the recovery time needed after GA.

Further analyses with multiple linear regression models showed that the overall cost saving with injection laryngoplasty was primarily driven by time-based factors such as operating theatre time and length of hospital stay. Therefore, this indicates that the overall cost of injection laryngoplasty performed under LA was lower compared to GA because of shorter operating theatre and procedure times. This study showed that an increase in operating theatre time by 1 minute would add approximately AU$43.08 to the total cost. This implies that significant cost savings could be achieved by moving these procedures to an out-patient setting, as it would negate the need for labour-intensive peri-operative nursing care and anaesthetic costs.

Interestingly, when time factors were excluded from the model, allowing consideration of patient factors such as age and American Society of Anesthesiologists scores, the type of anaesthesia emerged as an independent predictor of the total cost. Hence, type of anaesthesia could be used to predict the future cost savings of other laryngology procedures performed in the operating theatre of an equivalent duration. This study also showed that some direct and indirect costs were significantly different between the LA and GA groups because of the extra resources required for GA. However, the limitation of the small sample size in this study should be acknowledged. A cohort of 20 patients was generated over 2 years in a public hospital setting, which reflects the difficulty of working with a single-surgeon series.

Several studies in the field of ENT have demonstrated a significant decrease in operational costs for other procedures conducted in an office-based setting. Rees *et al*. were amongst the first to perform a detailed cost analysis of unsedated office-based pulse dye laser surgery for benign laryngeal pathology.[10] They reported an average saving of more than US$5000 per case when the procedure was moved to an office-based setting. Studies in North America and Europe have also demonstrated savings and cost effectiveness in office-based injection laryngoplasty.[2,5] Other specialties such as oncology, gastroenterology and orthopaedics have reported similar cost savings and efficiency in office-based procedures.[16–18] These findings indicate that savings can be made if the procedure is conducted in out-patient clinics, as operating theatre costs are avoided.

Our study analysed the costs of performing injection laryngoplasty under LA versus GA in a public tertiary teaching hospital in Australia. In contrast to public hospitals, the costs in a private hospital setting are more variable, as some of these ‘costs’ include rebates such as the Medicare Benefit Schedule and private hospital insurance reimbursement to the hospital and surgeon.

In our hospital, all injection laryngoplasties performed under LA are currently conducted in the operating theatre because there is no procedure room in the clinic and the equipment is currently located in the operating theatre for laryngological procedures. We propose that injection laryngoplasty performed under LA can be conducted safely in an out-patient clinic procedure room to further minimise costs and shorten hospital stay in an Australian healthcare setting. Modification of the clinic room to enable procedures would be cost-effective given the cost savings achieved by performing laryngological procedures under LA. However, the safety implications of performing laryngeal procedures in the out-patient setting are of utmost importance. Hence,

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procedures conducted in an office or out-patient setting require meticulous planning, particularly with regard to airway and resuscitation equipment, and expertise, in order to maintain patient safety and clinical efficacy.

- **Advancements in technology have enabled some laryngological procedures to be performed in-office**
- **In Australia, office-based injection laryngoplasty is not routinely performed**
- **The majority of procedures are currently conducted in the operating theatre, regardless of anaesthesia type**
- **In this study, injection laryngoplasty performed under local anaesthesia (LA) in the operating theatre decreased costs and hospital stay**
- **Further savings could be achieved if the LA procedures were performed in an out-patient setting**

In Australia, there are no national or state-based guidelines on performing injection laryngoplasty under LA in the out-patient setting. Furthermore, there are limited research and guidelines in the field of ENT to aid risk stratification and determine the choice of anaesthesia. In this study, injection laryngoplasty performed under GA was mainly driven by patient factors such as poor tolerance, high anxiety levels and brisk gag reflex. Other factors such as age, co-morbidities, social circumstances, patients' preference, American Society of Anesthesiologists score and anaesthetic history were also used when deciding on the anaesthetic modality.

Conclusion

This single-centre retrospective analysis, while small, provides valuable evidence on the significant cost savings and shorter length of hospital stay that can be achieved when injection laryngoplasty is conducted under LA in the operating theatre within an Australian healthcare setting. Further savings could be achieved if the LA procedures are performed in the out-patient setting, as the costs of operating theatre, anaesthetist and peri-operative nursing care can be avoided. Patients who are not suitable candidates for LA could be assigned to specific operating theatre lists for surgery to be performed under GA. Scoring-based criteria to assist in determining suitability for office-based laryngeal procedures under LA could be developed, to aid decision making, prevent complications and establish an efficient clinical management pathway for injection laryngoplasty.

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