FACULTY OF MEDICINE AND HEALTH SCIENCES

CLINICAL OUTCOMES AND COST-EFFECTIVENESS OF SUPERFICIAL PAROTIDECTOMY VERSUS EXTRACAPSULAR DISSECTION OF THE PAROTID GLAND

A SINGLE-CENTRE RETROSPECTIVE STUDY OF 161 PATIENTS

Robin Vanroose
Student number: 01706381

Supervisor(s): Prof. Dr. Erik Nout, Dr. Jan Scheerlinck, Dr. Renaat Coopman

A dissertation submitted to Ghent University in partial fulfilment of the requirements for the degree of Master of Science in Dentistry

Academic year: 2021 – 2022

GHENT UNIVERSITY

Preface

This is the final chapter of my education in dentistry at Ghent University, where I was taught scientific skills in addition to the practical skills that are part of a dental education. I was able to use this knowledge and these skills to bring this project to a satisfying result. Which in the end resulted in an acceptation in a leading international journal. However, I could not have achieved this result alone, for this I must thank some people.

First, I would like to thank Prof. Dr. Erik Nout for his guidance and patience, for proofreading and for his quick answers to my questions throughout the whole process. Without him, this work would not have reached publication. Furthermore, I must thank Dr. Jan Scheerlinck who supported me very personally during the process of data collection and the conceptualization of the study. I would also like to thank Dr. Renaat Coopman whose critical eye and extensive feedback in the final stage undoubtedly accelerated the acceptance. Additionally, I would like to thank the staff of the ETZ in Tilburg for the warm welcome during my visits and the help during the administrative procedures.

Finally, my parents who supported me during my studies and helped me to produce this work deserve thanks.

Article

Title and Running heads

Clinical outcomes and cost-effectiveness of superficial parotidectomy versus extracapsular dissection of the parotid gland: a single-centre retrospective study of 161 patients

Recto: Outcomes and cost-effectiveness SP vs ECD

Verso: Vanroose et al.

Key Words

Parotid gland, parotid neoplasms; Warthin tumor; pleomorphic adenoma; salivary gland neoplasms.

Authors

- Robin Vanroose

Department of Oral Health Sciences, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium

Department of Oral and Maxillofacial Surgery, Sint-Elisabeth Hospital, Tilburg, The Netherlands.

- Jan Scheerlinck

Department of Oral and Maxillofacial Surgery, Sint-Elisabeth Hospital, Tilburg, The Netherlands.

- Renaat Coopman

Department of Oral Health Sciences, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium

Department of Plastic, Reconstructive and Aesthetic Surgery, Ghent University Hospital, Ghent, Belgium.

- Erik Nout

Department of Oral Health Sciences, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium

Department of Oral and Maxillofacial Surgery, Sint-Elisabeth Hospital, Tilburg, The Netherlands.

Attributable to the following Department/Institution

Oral and Maxillofacial Surgery

ETZ Tilburg

Hilvarenbeekse Weg 60

5022 GC Tilburg, The Netherlands

Table of contents

Abstract

Improvements in preoperative diagnostics and intraoperative techniques have made the surgical excision of benign parotid gland tumours less invasive. Extracapsular dissection (ECD) has become more popular in comparison to superficial parotidectomy (SP), the gold standard. Although clinical outcomes have been reported, reports on cost-effectiveness are limited. The aim of this retrospective study was to analyse the surgical outcomes and cost-effectiveness of ECD versus SP in benign parotid tumour surgery. A retrospective cohort of 161 patients treated between 2012 and 2020 was collected. Data concerning demographics, clinical outcomes, and cost-efficiency were recorded. Analysis of the 161 unilateral parotidectomy cases (59 SP, 102 ECD) showed a significantly longer operation time, anaesthesia time, and length of stay for SP patients (all $P < 0.001$). Regarding postoperative complications, transient facial nerve weakness ($P < 0.001$) and haematoma formation ($P < 0.016$) were more prevalent in the SP patients. The frequency of positive margins was lower for SP ($P < 0.037$). No case of recurrence was identified with either technique. ECD showed excellent clinical outcomes as well as a reduction in complications when compared to SP. ECD is a viable alternative for superficial benign parotid gland tumours after thorough preoperative clinical, pathological, and radiological examination. The reduction in operation, anaesthesia, and hospitalization times with ECD is likely to result in a gain in cost-effectiveness.

Introduction

The parotid is the largest of the three major salivary glands[1]. Tumours in the salivary glands account for 0.2% to 1% of all cancers and 3% of all head and neck tumours. Eighty percent of salivary gland tumours (SGTs) are found in the parotid, of which 80% are benign[2–4]. Furthermore, 90% of the benign parotid tumours are located in the superficial lobe, due to the fact that 80% of the parotid parenchyma is found lateral to the facial nerve[5]. The fourth edition of the World Health Organization (WHO) Classification of Head and Neck Tumours (current version, 2017) includes 11 types of benign epithelial SGTs, of which pleomorphic adenoma is the most common, accounting for 65% of benign tumours; the second most common is Warthin tumour accounting for 25%.

Historically, intracapsular enucleation (SGT removal within its capsule) resulted in unacceptable recurrence rates of up to 45%. Therefore, new surgical techniques were developed to surgically remove benign SGTs of the parotid[5–7]. These include the superficial parotidectomy (SP), which involves complete removal of the superficial lobe of the parotid gland with facial nerve dissection, and the total parotidectomy, which involves complete removal of the superficial and deep lobes of the parotid gland with facial nerve dissection or transection. However, facial nerve dissection is associated with two important postoperative complications: temporary/permanent paresis/paralysis of the facial nerve and/or the development of Frey syndrome[8].

Intraoperative facial nerve monitoring and optical magnification, in addition to better preoperative diagnosis (ultrasound, fine needle aspiration cytology (FNAC), computed tomography, magnetic resonance imaging (MRI)) have enabled the surgeon to perform surgery in the parotid region more safely. These developments have allowed the scale of benign SGT surgery to be reduced from SP to extracapsular dissection (ECD), in which the SGT is removed with a margin of healthy salivary gland tissue, in an attempt to reduce postoperative complications[5].

SP is still considered the gold standard for the removal of benign parotid tumours[8,9], but ECD has been proposed as an alternative[5,6,10]. A meta-analysis by Albergotti et al.[11] reported less frequent facial nerve weakness and Frey syndrome and a recurrence rate similar to SP for ECD. However, the ECD cases appeared to have favourable characteristics, such as being singular, mobile, small (≤2.5 cm to 4 cm), and positioned far from the nerve and in the lateral and lower lobes, as illustrated in Fig. 1[12,13]. Foresta et al.[8] reported ECD as a viable option for benign lesions (≤4 cm) in the superficial lobe without nerve involvement, which was reiterated by Xie et al.[14]. There is still a lot of controversy regarding the criteria by which to choose either

ECD or SP, and there is a noticeable gap in the literature concerning cost-effectiveness comparisons between the two treatment modalities. Kato et al.[15] described favourable cost-effectiveness for ECD compared to SP for benign parotid tumours, although they stated that studies with a longer follow-up and larger populations were needed to determine whether the advantages would be maintained over time.

Fig. 1. (A) Ideal case for extracapsular dissection due to the superficial location and small size of the tumour, far from the facial nerve, axial view; (B) coronal view tumour figure 1A, ideal for extracapsular dissection due to the location in the posterior lower lobe; (C) Ideal case for superficial parotidectomy due to the deeper location and larger size, axial view; (D) coronal view tumour figure 1C.

The aim of this retrospective study was to analyse the surgical outcomes and cost-effectiveness of ECD versus SP in benign parotid tumour surgery.

Materials and methods

A retrospective evaluation covering the period 2012 to 2020 was performed in the Elisabeth-TweeSteden Ziekenhuis (Tilburg, The Netherlands). Inclusion criteria were patients who had undergone parotid surgery by ECD or SP surgical technique, who had preoperative FNAC and postoperative pathology reports available, and who had at least 1 year of clinical follow-up. Patients were excluded if they had primary malignant SGTs, secondary/metastatic malignancies, SGTs originating from the deep parotid lobe, had undergone revision surgery, or if a total parotidectomy was performed.

The preoperative evaluation included a clinical examination for mobility and firmness of the SGT. Furthermore, pain and facial nerve paresis were clinically investigated. Following the initial clinical investigation, ultrasound-guided FNAC and MRI were conducted to exclude signs of malignancy. All parotid surgeries were performed under general anaesthesia with operator-worn loupe magnification and facial nerve monitoring. The SP was performed by dissecting the plane of the facial nerve antegrade and removing all of the parotid mass above. The ECD was performed without planned exposure or dissection of the facial nerve branches. Instead, the tumour was removed along with a 2–3-mm rim of healthy tissue. Daily evaluation was performed during the hospital stay until discharge. Afterwards, a personalized follow-up schedule was implemented, which was adjusted according to the histopathological findings, surgical complications, and tumour type. Facial nerve function was evaluated during follow-up consultations; possible gustatory sweating was only investigated after 6 to 12 months. Postoperative radiotherapy was not performed for benign lesions.

Sociodemographic characteristics, surgical modality, length of the follow-up period, tumour type and location, and tumour recurrence data were extracted. Margins were defined as positive if the inked surface reached the resection margin in the histopathological analysis, or if tumour spill, capsule rupture, capsule perforation, or an incomplete capsule was reported during the surgery. Intraoperative events of prognostic significance, including sacrifice of a nerve, tumour spillage, etc., were also collected.

Cost-efficiency was assessed by secondary endpoints including the durations of surgery, anaesthesia, and hospitalization and the occurrence of postoperative complications. Due to the heterogeneity of the retrospective data, an estimate of the real cost as the primary endpoint was not feasible. The following definitions were used: operating time was the time from first incision to wound closure, anaesthesia time was the time from induction to extubation, and length of stay was the number of days in hospital.

The study was approved by the METC Brabant Ethics Committee.

Statistical method

The statistical analysis was performed on the anonymized data using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as frequencies, percentages, and/or range; numerical variables were presented as the mean ± standard deviation. Values were displayed in their respective tables. The normality of the data distribution for continuous variables was determined using a combination of the Kolmogorov–Smirnov test, skewness, kurtosis, and a visual examination of the distribution. Comparisons between continuous variables were done using the independent *t*-test (in the case of a normal distribution) or Mann–Whitney *U*-test (non-normal distribution). The categorical variables were coded using a variable dependent numerical coding system. For the categorical variables, comparisons were performed with Fisher's exact test or the Pearson χ^2 test. Statistical significance was considered with a *P*-value lower than 0.05. A line graph was drawn to depict the number of cases of each surgery type (ECD and SP) performed per year.

Results

A total of 161 parotidectomies met the inclusion criteria: 102 were performed by ECD (63.4%) and 59 by SP (36.6%) technique. There was a relative increase in the frequency of ECD during the study period (Fig. 2).

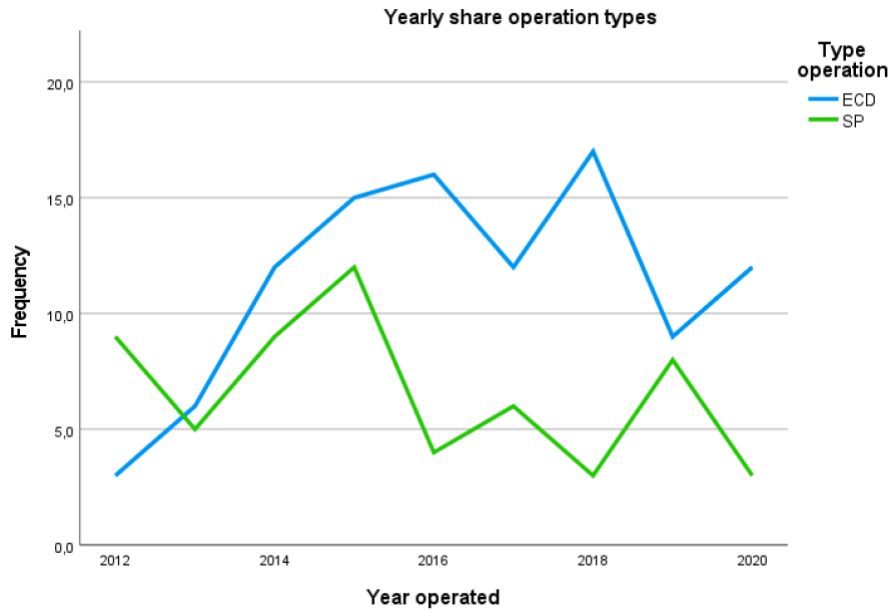

Fig. 2. Increase in relative frequency of extracapsular dissection (ECD) compared to superficial parotidectomy (SP).

The sex distribution differed significantly between the two groups ($P < 0.033$), with male patients more frequently undergoing SP. There was no significant difference in median age at surgery, smoking status, or lesion side between the groups (Table 1). Lesion size was found to be significantly larger ($P < 0.007$) and the duration of follow-up significantly longer ($P < 0.036$) in the SP group. The 5-year disease-specific survival was 100%. Pleomorphic adenoma was the most common lesion type, followed by Warthin tumour; other lesions were less common (Table 1). The frequency of positive margin status was significantly higher in the ECD group ($P < 0.037$); 24.5% of ECD cases had positive margins compared to 10.2% of SP cases.

Table 1. Demographic factors and features of the lesion in the extracapsular dissection (ECD) and superficial parotidectomy (SP) groups

	ECD (*n* = 102) *n* (%)	SP (*n* = 59) *n* (%)	*P*-value
Age at surgery (years), mean (range)	57 (22–83)	58 (23–81)	<0.714[a]
Sex			<0.033[b]
Male	51 (50)	40 (67.8)	
Female	51 (50)	19 (32.2)	
Lesion side			<0.744[b]
Right	54 (52.9)	29 (49.2)	
Left	48 (47.1)	30 (50.8)	
Smoking			<0.8[b]
Current	39 (38.2)	25 (42.4)	
Former	17 (16.7)	10 (16.9)	
Histopathological diagnosis			
Pleomorphic adenoma	52 (51.0)	27 (45.8)	
Warthin tumour	41 (40.2)	22 (37.3)	
Myoepithelioma	1 (1.0)	4 (6.8)	
Basal cell adenoma	1 (1.0)	1 (1.7)	
Cystadenoma	0 (0)	2 (3.4)	
Lymphadenoma	0 (0)	1 (1.7)	
Lymphangioma	1 (1.0)	0 (0)	
Lympho-epithelial cyst	2 (2.0)	2 (3.4)	
Spindle cell lipoma	1 (1.0)	0 (0)	
Ductal salivary cyst	1 (1.0)	0 (0)	
Retention cyst	1 (1.0)	0 (0)	
Reactive lymph node	1 (1.0)	0 (0)	
Lesion size (cm^3), mean (range)	52 (1.4–380)	76 (3.4–390)	<0.007[c]
Margin status			<0.037[b]
Positive	25 (24.5)	6 (10.2)	
Negative	77 (75.5)	53 (89.8)	
Follow-up (years), mean (range)	4.19 (1–9)	4.98 (1–9)	<0.036[a]

[a]Independent *t*-test.

[b]Pearson χ^2 test.

[c]Mann–Whitney *U*-test.

Table 2 shows the comparison of reported intraoperative events between the ECD and SP groups. In 30.4% of ECD cases, the facial nerve was exposed due to proximity to the tumour; the nerve was left intact in these cases. The facial nerve was transected in two cases, both in the SP group. A statistically significant difference in greater auricular nerve transection was found, due to the method of surgery in the SP group, whereby the greater auricular nerve is transected after incision.

Table 2. Intraoperative events.

	ECD (*n* = 102) *n* (%)	SP (*n* = 59) *n* (%)	*P*-value
Greater auricular nerve transected	9 (8.8)	59 (100)	<0.001[a]
Facial nerve branch transected	0 (0)	2 (3.4)	<0.133[b]
Facial nerve branch exposed	31 (30.4)	59 (100)	<0.001[a]
Retromandibular vein sacrificed	1 (1.0)	2 (3.4)	<0.555[b]

ECD, extracapsular dissection; SP, superficial parotidectomy.

[a]Pearson χ^2 test.

[b]Fisher's exact test.

The preoperative FNAC diagnosis was confirmed by the final pathological diagnosis in 79,5% of the cases, as shown in Table 3. Preoperative FNAC was inconclusive in 16 cases. Four cases of cystic lesions were suspected, and one reactive lymph node. Four cases were suspected to be pleomorphic adenoma and two cases to be Warthin tumour but could not be definitively identified.

Table 3. Comparison between preoperative FNAC and final pathology.

FNAC pathology	Number (%)	Final pathology	Number (%)
Pleomorphic adenoma	75 (46.6)	Pleomorphic adenoma	79 (49.1)
Warthin tumour	55 (34.2)	Warthin tumour	63 (39.1)
Likely pleomorphic adenoma	4 (2.5)	Myoepithelioma	5 (3.1)
Likely Warthin tumour	2 (1.2)	Basal cell adenoma	2 (1.2)
Basal cell adenoma	2 (1.2)	Cystadenoma	2 (1.2)
Myoepithelioma	1 (0.6)	Lymphadenoma	1 (0.6)
Spindle cell lipoma	1 (0.6)	Lymphangioma	1 (0.6)
Cystic lesion	4 (2.5)	Lympho-epithelial cyst	4 (2.5)
Reactive lymph node	1 (0.6)	Spindle cell lipoma	1 (0.6)
Classification not possible	16 (10)	Ductal salivary cyst	1 (0.6)
		Retention cyst	1 (0.6)
		Reactive lymph node	1 (0.6)

FNAC, fine needle aspiration cytology.

Concerning the operation time, anaesthesia time, and length of hospital stay, statistically significant differences were found between the two procedures, as shown in Table 4. The operation time was found to be significantly shorter in the ECD group ($P < 0.001$). This also translated into a substantially shorter anaesthesia time ($P < 0.001$). The mean operation time in the ECD group was 69 ± 27 minutes, while this was 140 ± 23 minutes in the SP group. The anaesthesia time was 98 ± 28 minutes in the ECD group and 172 ± 27 minutes in the SP group. After the operation, patients in the ECD group were found to stay considerably shorter in the hospital ($P < 0.001$): a mean 0.7 ± 0.5 days, compared to 1.2 ± 0.5 days in the SP group.

Table 4. Cost-effectiveness characteristics.

	ECD Mean ± SD	SP Mean ± SD	*P*-value
Operation time (min)	69 ± 27	140 ± 23	<0.001[a]
Anaesthesia time (min)	98 ± 28	172 ± 27	<0.001[a]
Length of stay (days)	0.7 ± 0.5	1.2 ± 0.5	<0.001[a]

ECD, extracapsular dissection; SP, superficial parotidectomy; SD, standard deviation.

[a]Mann–Whitney *U*-test.

The SP and ECD complication rates were comparable in all categories, except for facial nerve palsy ($P < 0.001$), temporary facial nerve palsy ($P < 0.001$), and haematoma formation ($P < 0.016$), which were more prevalent following SP (Table 5). Sixteen (27.1%) cases of temporary facial nerve weakness were reported in the SP group and four (3.9%) in the ECD group. Haematoma formation was present in nine (15.3%) SP cases and four (3.9%) ECD cases. No statistically significant difference in permanent facial nerve weakness was found ($P < 0.133$).

Table 5. Postoperative complication rates.

	ECD (*n* = 102) *n* (%)	SP (*n* = 59) *n* (%)	*P*-value
Frey syndrome (gustatory sweating)	1 (1.0)	3 (5.1)	<0.140[a]
Facial nerve palsy			<0.001[a]
Temporary	4 (3.9)	16 (27.1)	<0.001[b]
Permanent	0 (0)	2 (3.4)	<0.133[a]
Dysesthesia of the greater auricular nerve			<0.214[a]
Temporary	4 (3.9)	1 (1.7)	<0.653[a]
Permanent	5 (4.9)	7 (12)	<0.125[a]
Seroma formation	0 (0)	2 (3.4)	<0.133[a]
Sialocele formation	2 (2.0)	1 (1.7)	1[a]
Salivary fistula formation	1 (1.0)	3 (5.1)	<0.140[a]
Haematoma	4 (3.9)	9 (15.3)	<0.016[a]
Infection	1 (1.0)	2 (3.4)	<0.555[a]

ECD, extracapsular dissection; SP, superficial parotidectomy.

[a]Fisher's exact test.

[b]Pearson χ^2 test.

Discussion

In this study, significant differences were found between the SP and ECD groups in operation, anaesthesia, and hospitalization times. The mean operation time was significantly shorter in the ECD group; the longer surgery time in the SP group can be attributed to the time required for facial nerve identification. As a consequence, the mean anaesthesia time was also significantly reduced in the ECD group. Postoperatively the ECD group had a shorter hospital stay, with most patients in this group discharged on the same day with a drain in situ. They were seen later at an outpatient evaluation to remove the drain.

Kato et al.[15] reported mean operation and anaesthesia times of 83 minutes and 148 minutes, respectively, in their ECD patient group and 139 minutes and 213 minutes, respectively, in their SP patient group; the differences between the two groups were statistically significant. A significant difference in length of hospitalization was also reported in their study: 0.5 days for ECD patients compared to 1.3 days for SP patients. In another study, Barzan and Pin[7] reported a mean operation time of 60 minutes for ECD and 150 minutes for SP. These results are in line with the results found in the present study and indicate that SP surgery takes approximately double the time of ECD surgery. Therefore, the possibility of performing two ECD procedures in the time of one SP arises. A shorter hospitalization and procedure are likely to result in lower health care costs for the patient and society[15]. The real cost of total benign parotid gland tumour surgery as a primary endpoint is almost impossible to determine. No literature was found on this topic. Further studies with a more economic focus will be needed to express the cost-efficiency in real monetary terms.

Transient facial nerve palsy occurred in 27.1% of the SP cases and only 3.9% of the ECD cases (P = 0.001) in this study. This is comparable to the results of studies in the current literature, which have reported lower rates of transient and permanent facial nerve palsy with the ECD technique as well[7,8,14,16]. In the meta-analysis by Xie et al.[14] and study by Mantsopoulos et al.[17], Frey syndrome was reported to be significantly less prevalent after ECD. In the present study, Frey syndrome occurred in one (1.0%) ECD case and three (5.1%) SP cases, with no significant difference between the groups (P < 0.140), due to small numbers. Haematoma formation occurred more in the SP procedure than in ECD (P < 0.016). The reported complications can adversely affect quality of life, which shows the benefit of ECD due to the lower incidence of complications. Quality of life should be considered in comparisons between the two surgical modalities[18].

No cases of recurrence were identified in this study, probably due to the limited follow-up. Martin et al.[19] stated that due to the clinical nature of benign lesions, a follow-up time of at least

10 years is necessary to reliably evaluate the recurrence rate; this was not achieved in the present study. However, ECD has only recently been introduced at Elisabeth-TweeSteden Ziekenhuis to treat benign parotid lesions, although the relative share of ECD is increasing. Brennan et al.[9] and Mantsopoulos et al.[20] showed similar trends.

In the literature, recurrence has been reported to occur up to 20 years postoperative, with varying recurrence rates and significance for ECD and SP[8,11,14,19,21,22]. Foresta et al.[8] reported a higher recurrence rate in their SP group: 2.3 cases per 1000 person-years for SP compared to 0.2 cases per 1000 person-years in the ECD group. A recent meta-analysis by Martin et al.[19] also reported a higher recurrence rate in the SP group. However, in these meta-analyses, ECD was used for relatively smaller parotid gland tumours compared to SP, resulting in a selection bias, which was also found in the present study, and could be a reason for the higher recurrence rate for SP described in the studies above. As a result of the inherent differences between the two procedures, ECD might be assumed to have narrower margins due to the dissection close to the capsule[7,19]. However, this disadvantage is present in a large part of SP cases too, due to the close location of the tumour against the nerve caused by the size of the tumour, thus necessitating a dissection step[7,8]. Consequently, early removal is essential to prevent the need for the extra dissection step with higher chances of recurrence in SP. This way a cuff of healthy tissue is preserved, which prevents capsule rupture and potential spillage of the tumour contents – two of the reported risk factors for recurrence[8,11,13,23]. A barrier of healthy tissue also assists in less pseudopodia and tumour satellites being left behind[13]. In ECD, no common guideline exists regarding the required thickness of tissue left around the tumour, with different thicknesses being reported by different authors[6,13,16].

Despite the aforementioned advantages with respect to the ECD procedure, not all cases can be treated with this technique. Location plays an important role, with tumours of any size in the posterior lower lobe being favourable for removal by ECD. Pre-auricular lesions favour SP due to the closer location to the facial nerve trunk. Moreover, tumours with an intrinsic higher chance of recurrence and tumours localized in the deeper lobe of the parotid gland are removed with SP or total parotidectomy, resulting in selection bias[10,13].

Secondary ECD is primarily indicated for benign tumours, but potential false-negative preoperative assessment should be considered[13]. A strict diagnostic protocol is necessary to discriminate between benign and malignant tumours; a combination of ultrasound-guided FNAC, clinical examination (benign SGTs usually do not affect the facial nerve and are almost always freely mobile), and MRI should be used[9,16].

A recent meta-analysis by Liu et al.[2] showed FNAC to have a sensitivity of 88% and specificity of 99.5% for discriminating between benign and malignant parotid tumours, with better results when ultrasound-guided. The Milan classification is a new tool to grade the degree of malignant potential of FNAC material from parotid tumours and is useful for determining the treatment protocol; a score of ≥5 represents a malignant lesion. This classification system was not applied in the cases included in the present study, but its more broad use in clinical practice and reporting of results in the literature is recommended[24]. The Milan classification has been implemented at Elisabeth-TweeSteden Ziekenhuis since 2018, with cases at risk of malignancy expedited for surgery.

In the present study, FNAC provided a correct final diagnosis in 79.5% of cases; no definitive diagnosis could be made in 20.5%. Therefore, the situation arises where a tumour is preoperatively believed to be benign based on clinical (mobility, unilocularity, location, depth) and radiographic (well-defined margins, no enlarged lymph nodes) characteristics, but turns out to be malignant on postoperative histopathological analysis. If the course of the disease was shown to be negatively altered after performing ECD on those malignant lesions masquerading as benign, the widespread use of the new treatment method would be limited. An alternative to FNAC is ultrasound-guided true core biopsy. A histological tissue sample may provide more diagnostic certainty than an aspirate obtained by FNAC. Mantsopoulos et al.[25] described no adverse effect on survival and postoperative quality of life in these cases where due to a false negative preoperative report extracapsular dissection was performed. Furthermore, the surgeon must be able to deviate from a planned ECD and switch to more invasive/traditional surgery if signs of malignancy are detected[10,13].

This study has some limitations. No cases of recurrence were identified, probably related to the limited follow-up together with the slow-growing nature of these tumours. A selection bias was also identified, since SP was performed in the more complex cases and for larger tumours, and total parotidectomy cases were not included in the study. Facial nerve weakness, greater auricular nerve weakness, and Frey syndrome were reported on a clinical basis without the use of the House–Brackmann grading system, sensory index score, or starch iodine test, respectively[19,26]. In future studies, the aesthetic outcomes of the surgical incisions could also be investigated. The Milan classification was not used to grade the degree of malignant potential after FNAC. This classification could potentially be used in future studies to objectively grade the FNAC reports in institutions where FNAC is primarily used. As this was a retrospective file analysis, caution is needed when interpreting the reported results.

In this study, the extracapsular dissection technique showed better clinical outcomes as well as reduced complications when compared to the superficial parotidectomy technique in the

selected cases. Therefore, after careful preoperative examination using FNAC, ultrasound, MRI, and clinical evaluation, the extracapsular dissection technique is a suitable alternative to superficial parotidectomy in well indicated and correctly located tumours, namely benign well-defined superficial mobile lesions, especially in the posterior lower lobe. Surgeons should, however, be able to switch between the two surgical modalities when intraoperative findings indicate the need for a more extensive debulking.

Acknowledgements

Funding

None

Competing interests

None

Ethical approval

The study was approved by the METC Brabant Ethics Committee.

Patient consent

Patient consent was not required.

References

1. Kochhar A, Larian B, Azizzadeh B. Facial Nerve and Parotid Gland Anatomy. Otolaryngol Clin North Am. 2016;49(2):273-84.
2. Liu CC, Jethwa AR, Khariwala SS, Johnson J, Shin JJ. Sensitivity, Specificity, and Posttest Probability of Parotid Fine-Needle Aspiration: A Systematic Review and Meta-analysis. Otolaryngol Head Neck Surg. 2016;154(1):9-23.
3. Dell'aversana Orabona G, Salzano G, Petrocelli M, Iaconetta G, Califano L. Reconstructive techniques of the parotid region. J Craniofac Surg. 2014;25(3):998-1002.
4. Johns ME, Goldsmith MM. Incidence, diagnosis, and classification of salivary gland tumors. Part 1. Oncology (Williston Park). 1989;3(2):47-56; discussion , 8, 62.
5. Witt RL, Iro H, McGurk M. The Role of Extracapsular Dissection for Benign Parotid Tumors. Current Otorhinolaryngology Reports. 2014;2(2):55-63.
6. Klintworth N, Zenk J, Koch M, Iro H. Postoperative complications after extracapsular dissection of benign parotid lesions with particular reference to facial nerve function. Laryngoscope. 2010;120(3):484-90.
7. Barzan L, Pin M. Extra-capsular dissection in benign parotid tumors. Oral Oncol. 2012;48(10):977-9.
8. Foresta E, Torroni A, Di Nardo F, de Waure C, Poscia A, Gasparini G, et al. Pleomorphic adenoma and benign parotid tumors: extracapsular dissection vs superficial parotidectomy--review of literature and meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol. 2014;117(6):663-76.
9. Brennan PA, Ammar M, Matharu J. Contemporary management of benign parotid tumours - the increasing evidence for extracapsular dissection. Oral Dis. 2017;23(1):18-21.
10. Iro H, Zenk J. Role of extracapsular dissection in surgical management of benign parotid tumors. JAMA Otolaryngol Head Neck Surg. 2014;140(8):768-9.
11. Albergotti WG, Nguyen SA, Zenk J, Gillespie MB. Extracapsular dissection for benign parotid tumors: a meta-analysis. Laryngoscope. 2012;122(9):1954-60.
12. McGurk M, Thomas BL, Renehan AG. Extracapsular dissection for clinically benign parotid lumps: reduced morbidity without oncological compromise. Br J Cancer. 2003;89(9):1610-3.
13. Deschler DG. Extracapsular dissection of benign parotid tumors. JAMA Otolaryngol Head Neck Surg. 2014;140(8):770-1.
14. Xie S, Wang K, Xu H, Hua RX, Li TZ, Shan XF, et al. PRISMA-Extracapsular Dissection Versus Superficial Parotidectomy in Treatment of Benign Parotid Tumors: Evidence From 3194 Patients. Medicine (Baltimore). 2015;94(34):e1237.

15. Kato MG, Erkul E, Nguyen SA, Day TA, Hornig JD, Lentsch EJ, et al. Extracapsular Dissection vs Superficial Parotidectomy of Benign Parotid Lesions: Surgical Outcomes and Cost-effectiveness Analysis. JAMA Otolaryngol Head Neck Surg. 2017;143(11):1092-7.
16. Dell'Aversana Orabona G, Bonavolonta P, Iaconetta G, Forte R, Califano L. Surgical management of benign tumors of the parotid gland: extracapsular dissection versus superficial parotidectomy--our experience in 232 cases. J Oral Maxillofac Surg. 2013;71(2):410-3.
17. Mantsopoulos K, Koch M, Klintworth N, Zenk J, Iro H. Evolution and changing trends in surgery for benign parotid tumors. Laryngoscope. 2015;125(1):122-7.
18. Ciuman RR, Oels W, Jaussi R, Dost P. Outcome, general, and symptom-specific quality of life after various types of parotid resection. Laryngoscope. 2012;122(6):1254-61.
19. Martin H, Jayasinghe J, Lowe T. Superficial parotidectomy versus extracapsular dissection: literature review and search for a gold standard technique. Int J Oral Maxillofac Surg. 2020;49(2):192-9.
20. Mantsopoulos K, Scherl C, Iro H. Investigation of arguments against properly indicated extracapsular dissection in the parotid gland. Head Neck. 2017;39(3):498-502.
21. Kanatas A, Ho MWS, Mücke T. Current thinking about the management of recurrent pleomorphic adenoma of the parotid: a structured review. Br J Oral Maxillofac Surg. 2018;56(4):243-8.
22. Bradley PJ. The recurrent pleomorphic adenoma conundrum. Curr Opin Otolaryngol Head Neck Surg. 2018;26(2):134-41.
23. Witt RL. The significance of the margin in parotid surgery for pleomorphic adenoma. Laryngoscope. 2002;112(12):2141-54.
24. Baloch ZW, Faquin WC, Layfield LJ. Is it time to develop a tiered classification scheme for salivary gland fine-needle aspiration specimens? Diagn Cytopathol. 2017;45(4):285-6.
25. Mantsopoulos K, Velegrakis S, Iro H. Unexpected Detection of Parotid Gland Malignancy during Primary Extracapsular Dissection. Otolaryngol Head Neck Surg. 2015;152(6):1042-7.
26. Hegazy MAF, Nahas WE, Roshdy S. Surgical outcome of modified versus conventional parotidectomy in treatment of benign parotid tumors. Journal of Surgical Oncology. 2011;103(2):163-8.

Dutch Summary

Verbeteringen in preoperatieve diagnostiek en intraoperatieve technieken hebben de chirurgische excisie van goedaardige parotiskliertumoren minder invasief gemaakt. Extracapsulaire dissectie (ECD) werd populairder in vergelijking met oppervlakkige parotidectomie (SP), de gouden standaard. Er zijn wisselende klinische resultaten gerapporteerd en er zijn weinig rapporten over kosteneffectiviteit. Het doel van deze studie was om retrospectief de chirurgische uitkomsten en de kosteneffectiviteit van de extracapsulaire parotidectomie versus de oppervlakkige parotidectomie te analyseren bij de chirurgie van benigne parotidumoren. Retrospectief werd een cohorte van 161 patiënten verzameld tussen 2012-2020. Gegevens over demografie, klinisch resultaat en kostenefficiëntie werden verzameld. 161 unilaterale parotidectomieën (59 SP en 102 ECD) toonden aan dat SP significant langere procedure-, anesthesie- en hospitalisatieduur had ($p<0,001$). Postoperatief kwam voorbijgaande nervus facialis zwakte en hematoomvorming vaker voor bij SP ($p<0,001$ en $p<0,03$). Oppervlakkige parotidectomie toonde minder positieve marges ($p<0,037$). Bij beide technieken konden geen gevallen van recidief worden vastgesteld. ECD laat uitstekende klinische resultaten zien, evenals een vermindering van complicaties in vergelijking met SP. ECD is een levensvatbaar alternatief voor oppervlakkige goedaardige parotiskliertumoren na grondig preoperatief klinisch, pathologisch en radiologisch onderzoek. Vermindering van operatie-, anesthesie- en hospitalisatietijd als gevolg van ECD zal waarschijnlijk resulteren in een winst in kosteneffectiviteit.

Addendum

Medical Ethics comittee approval

MEDISCH ETHISCHE TOETSINGSCOMMISSIE BRABANT

R. Vanroose, E. Nout
ETZ
Afdeling: MKA
Postbus 90151
5000 LC Tilburg

Phone : 013-2218006
E-mail : info@metcbrabant.nl
Reference : METC Brabant/21.117
Date : 08-03-2021

Declaration concerning review applicability WMO

	Niet-WMO verklaring	METC nr	NW2021-23
Titel Onderzoek:	**Superficial parotidectomy vs extracapsular dissection** Clinical outcomes and cost-effectiveness of superficial parotidectomy versus extracapsular dissection of the parotid gland **NW2021-23**		

Dear Erik Nout, dear Robin Vanroose,

In the meeting of March 8, 2021, the accredited medical research ethics committee (MREC)Brabant considered whether or not the implementation of the above-mentioned intended study falls within the scope and associated obligations of the Medical Scientific Research Involving Human Subjects Act. (WMO)

During that assessment, the METC Brabant had the following information provided by you:
• A1. Submission letter from R. Vanroose and Prof. E. Van Nout dated 28.01.2021 with the request for a statement regarding WMO obligation for the above mentioned study;
• C1. Study protocol: Clinical outcomes and cost-effectiveness of superficial parotidectomy versus extracapsular dissection of the parotid gland, no version number, undated.

Based on the information you have provided, the METC Brabant has determined that the Medical Research Involving Human Subjects Act is not applicable for the above mentioned study you intend to carry out.

Motivation:
• Persons are not subjected to any action nor is any behavior imposed

The METC Brabant emphasizes that the assessment carried out and the statement issued in this regard only relates to the question of whether or not the research you intend to conduct (or research to be carried out under your responsibility) falls within the scope of the WMO.

The assessment and this statement do not constitute a substantive assessment by the MREC Brabant of the relevance, quality and conformity with applicable laws, regulations and ethical requirements of this research.

The MREC Brabant would therefore expressly point out that it is the responsibility of the researcher and/or the institution in which the research is carried out to determine or have it determined whether the intended research meets the legal, ethical and quality requirements.

If desired, the MREC Brabant can provide you with advice on these aspects.

Sincerely,
On behalf of the MREC Brabant

E.M. van Heertum
Secretary

Translation: HvH

METC Brabant: Medisch Ethische ToetsingsCommissie Brabant
Bezoekadres: Hasseltveste Dr. Deelenlaan 9 5042 AD Tilburg | Postadres: Postbus 90151, 5000 LC Tilburg
Telefoon: 013 2218006 | E-mail: info@metcbrabant.nl
Bankrelatie: ABN AMRO Tilburg NL78ABNA 0560682824 | KvK nummer: 18057718

Declaration Form

Declaration Form

Journal: INTERNATIONAL JOURNAL OF ORAL & MAXILLOFACIAL SURGERY	**Title of Paper**: **Clinical outcomes and cost-effectiveness of superficial parotidectomy versus extracapsular dissection of the parotid gland, a one-centre, retrospective study of 161 patients**

Declarations

The following additional information is required for submission. Please note that failure to respond to these questions/statements will mean your submission will be returned to you. If you have nothing to declare in any of these categories then this should be stated.

Please state any conflict of interests. A conflict of interest exists when an author or the author's institution has financial or personal relationships with other people or organisations that inappropriately influence (bias) his or her actions. Financial relationships are easily identifiable, but conflicts can also occur because of personal relationships, academic competition, or intellectual passion. A conflict can be actual or potential, and full disclosure to The Editor is the safest course.

Competing Interests

The author(s) declare no conflict of interest concerning research, authorship and publication.

Please state any sources of funding for your research

The research, authorship and/or publication of this article was performed without receiving external or internal funding.

DOES YOUR STUDY INVOLVE HUMAN OR ANIMALSUBJECTS?

YES

If your study involves human or animal subjects or records of human patients you MUST have obtained ethical approval. Ethics approval or exemption are required for retrospective studies on patients' records

Please state whether Ethical Approval was given, by whom and the relevant Judgement's reference number. A COPY OF THE ETHICAL APPROVAL OR EXEMPTION LETTER MUST BE UPLOADED WITH YOUR SUBMISSION

The study is approved by the local Medical Ethics Committee: METC BRABANT.
Reference number: NW2021-23

Patient Consent – please state whether written patient consent has been obtained. Please note that patient consent is always required to publish single case reports and clinical photographs. The Journal may request a copy of this consent, however the patient consent form should not be included in your submission. This should be available on request by the Editor. If patient consent was not required, please state this.

Patient consent has not been obtained for the data extraction, as this was not required by the local ethics committee.

Please add a statement to confirm that all authors have viewed and agreed to the submission

All authors have read the publication and agree to the submission.

This information must also be inserted into your manuscript under the acknowledgements section prior to the References.

Cover Letter

Cover letter

Nabil Samman
Editor-in-Chief
International Journal of Oral & Maxillofacial Surgery

March 9th, 2022

Dear Prof. Dr. Nabil Samman:

I would like to submit the manuscript entitled "Clinical outcomes and cost-effectiveness of superficial parotidectomy versus extracapsular dissection of the parotid gland, a one-centre, retrospective study of 161 patients" by Robin Vanroose, Jan Scheerlinck, Renaat Coopman and Erik Nout to be considered for publication as a research paper in the *International Journal of Oral & Maxillofacial Surgery*.

The aim of this study was to retrospectively analyze the surgical outcome and cost-effectiveness of extracapsular dissection (ECD) versus superficial parotidectomy (SP) in benign parotid tumor surgery. There is still a lot of controversy about criteria to choose for either ECD or SP and there is a noticeable gap in literature concerning cost-effectiveness comparisons between the two treatment modalities. Our study shows that SP has significantly longer procedure, anesthesia and hospitalization time and that post-operative transient facial nerve weakness and hematoma formation were more prevalent in SP. Therefore, ECD is a viable alternative for superficial benign PGTs after thorough preoperative clinical, pathological and radiological examination. We believe these findings will be of interest to the readers of your journal.

We declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We know of no conflicts of interest associated with this publication, and there has been no significant financial support for this work that could have influenced its outcome. As Corresponding Author, I confirm that the manuscript has been read and approved for submission by all the named authors.

We hope you find our manuscript suitable for publication and look forward to hearing from you in due course.

Sincerely,

Robin Vanroose
Department of Oral and Maxillofacial Surgery, ETZ Tilburg
Hilvarenbeekse Weg 60
5022 GC Tilburg
The Netherlands
Tel./Fax: +32479103297
Email: robin.vanroose@ugent.be

Int. J. Oral Maxillofac. Surg. 2021; xx: 1–8
https://doi.org/10.1016/j.ijom.2022.05.001, available online at https://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper
Clinical Pathology

Clinical outcomes and cost-effectiveness of superficial parotidectomy versus extracapsular dissection of the parotid gland: a single-centre retrospective study of 161 patients

R. Vanroose[a,b], J. Scheerlinck[b], R. Coopman[a,c], E. Nout[a,b]

[a]Department of Oral Health Sciences, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium; [b]Department of Oral and Maxillofacial Surgery, Sint-Elisabeth Hospital, Tilburg, the Netherlands; [c]Department of Plastic, Reconstructive and Aesthetic Surgery, Ghent University Hospital, Ghent, Belgium

R. Vanroose, J. Scheerlinck, R. Coopman, E. Nout: Clinical outcomes and cost-effectiveness of superficial parotidectomy versus extracapsular dissection of the parotid gland: a single-centre retrospective study of 161 patients. Int. J. Oral Maxillofac. Surg. 2021; xx: 1–8.

Abstract. Improvements in preoperative diagnostics and intraoperative techniques have made the surgical excision of benign parotid gland tumours less invasive. Extracapsular dissection (ECD) has become more popular in comparison to superficial parotidectomy (SP), the gold standard. Although clinical outcomes have been reported, reports on cost-effectiveness are limited. The aim of this retrospective study was to analyse the surgical outcomes and cost-effectiveness of ECD versus SP in benign parotid tumour surgery. A retrospective cohort of 161 patients treated between 2012 and 2020 was collected. Data concerning demographics, clinical outcomes, and cost-efficiency were recorded. Analysis of the 161 unilateral parotidectomy cases (59 SP, 102 ECD) showed a significantly longer operation time, anaesthesia time, and length of stay for SP patients (all $P < 0.001$). Regarding postoperative complications, transient facial nerve weakness ($P < 0.001$) and haematoma formation ($P = 0.016$) were more prevalent in the SP patients. The frequency of positive margins was lower for SP ($P = 0.037$). No case of recurrence was identified with either technique. ECD showed excellent clinical outcomes as well as a reduction in complications when compared to SP. ECD is a viable alternative for superficial benign parotid gland tumours after thorough preoperative clinical, pathological, and radiological examination. The reduction in operation, anaesthesia, and hospitalization times with ECD is likely to result in a gain in cost-effectiveness.

Keywords: Parotid gland; Parotid neoplasms; Warthin tumor; Pleomorphic adenoma; Salivary gland neoplasms.
Abbreviations: ECD; Extracapsular dissection; SPSuperficial parotidectomy; SGTSalivary gland tumour; FNACFine needle aspiration cytology; MRIMagnetic resonance imaging.

Accepted for publication 5 May 2022
Available online xxxx

0901-5027/xx0001 + 08

Please cite this article as: R. Vanroose, J. Scheerlinck, R. Coopman et al., Clinical outcomes and cost-effectiveness of superficial parotidectomy versus extracapsular dissection of the parotid gland: a single-centre retrospective study of 161 patients, Int. J. Oral Maxillofac. Surg, https://doi.org/10.1016/j.ijom.2022.05.001

The parotid is the largest of the three major salivary glands.[1] Tumours in the salivary glands account for 0.2–1% of all cancers and 3% of all head and neck tumours. Eighty percent of salivary gland tumours (SGTs) are found in the parotid, of which 80% are benign.[2–4] Furthermore, 90% of the benign parotid tumours are located in the superficial lobe, due to the fact that 80% of the parotid parenchyma is found lateral to the facial nerve.[5] The fourth edition of the World Health Organization (WHO) Classification of Head and Neck Tumours (current version, 2017) includes 11 types of benign epithelial SGTs, of which pleomorphic adenoma is the most common, accounting for 65% of benign tumours; the second most common is Warthin tumour accounting for 25%.

Historically, intracapsular enucleation (SGT removal within its capsule) resulted in unacceptable recurrence rates of up to 45%. Therefore, new surgical techniques were developed to surgically remove benign SGTs of the parotid.[5–7] These include the superficial parotidectomy (SP), which involves complete removal of the superficial lobe of the parotid gland with facial nerve dissection, and the total parotidectomy, which involves complete removal of the superficial and deep lobes of the parotid gland with facial nerve dissection or transection. However, facial nerve dissection is associated with two important postoperative complications: temporary/permanent paresis/paralysis of the facial nerve and/or the development of Frey syndrome.[8]

Intraoperative facial nerve monitoring and optical magnification, in addition to better preoperative diagnosis (ultrasound, fine needle aspiration cytology (FNAC), computed tomography, magnetic resonance imaging (MRI)) have enabled the surgeon to perform surgery in the parotid region more safely. These developments have allowed the scale of benign SGT surgery to be reduced from SP to extracapsular dissection (ECD), in which the SGT is removed with a margin of healthy salivary gland tissue, in an attempt to reduce postoperative complications.[5]

SP is still considered the gold standard for the removal of benign parotid tumours,[8,9] but ECD has been proposed as an alternative.[5,6,10] A meta-analysis by Albergotti et al.[11] reported less frequent facial nerve weakness and Frey syndrome and a recurrence rate similar to SP for ECD. However, the ECD cases appeared to have favourable characteristics, such as being singular, mobile, small (≤2.5–4 cm), and positioned far from the nerve and in the lateral and lower lobes, as illustrated in Fig. 1.[12,13] Foresta et al.[8] reported ECD as a viable option for benign lesions (≤4 cm) in the superficial lobe without nerve involvement, which was reiterated by Xie et al..[14] There is still a lot of controversy regarding the criteria by which to choose either ECD or SP, and there is a noticeable gap in the literature concerning cost-effectiveness comparisons between the two treatment modalities. Kato et al.[15] described favourable cost-effectiveness for ECD compared to SP for benign parotid tumours, although they stated that studies with a longer follow-up and larger populations were needed to determine whether the advantages would be maintained over time.

The aim of this retrospective study was to analyse the surgical outcomes and cost-effectiveness of ECD versus SP in benign parotid tumour surgery.

Materials and methods

A retrospective evaluation covering the period 2012–2020 was performed in the Elisabeth-TweeSteden Ziekenhuis (Tilburg, The Netherlands). Inclusion criteria were patients who had undergone parotid surgery by ECD or SP surgical technique, who had preoperative FNAC and postoperative pathology reports available, and who had at least 1 year of clinical follow-up. Patients were excluded if they had primary malignant SGTs, secondary/metastatic malignancies, SGTs originating from the deep parotid lobe, had undergone revision surgery, or if a total parotidectomy was performed.

The preoperative evaluation included a clinical examination for mobility and firmness of the SGT. Furthermore, pain and facial nerve paresis were clinically investigated. Following the initial clinical investigation, ultrasound-guided FNAC and MRI were conducted to exclude signs of malignancy. All parotid surgeries were performed under general anaesthesia with operator-worn loupe magnification and facial nerve monitoring. The SP was performed by dissecting the plane of the facial nerve antegrade and removing all of the parotid mass above. The ECD was performed without planned exposure or dissection of the facial nerve branches. Instead, the tumour was removed along with a 2–3-mm rim of healthy tissue. Daily evaluation was performed during the hospital stay until discharge. Afterwards, a personalized follow-up schedule was implemented, which was adjusted according to the histopathological findings, surgical complications, and tumour type. Facial nerve function was evaluated during follow-up consultations; possible gustatory sweating was only investigated after 6–12 months. Postoperative radiotherapy was not performed for benign lesions.

Sociodemographic characteristics, surgical modality, length of the follow-up period, tumour type and location, and tumour recurrence data were extracted. Margins were defined as positive if the inked surface reached the resection margin in the histopathological analysis, or if tumour spill, capsule rupture, capsule perforation, or an incomplete capsule was reported during the surgery. Intraoperative events of prognostic significance, including sacrifice of a nerve, tumour spillage, etc., were also collected.

Cost-efficiency was assessed by secondary endpoints including the durations of surgery, anaesthesia, and hospitalization and the occurrence of postoperative complications. Due to the heterogeneity of the retrospective data, an estimate of the real cost as the primary endpoint was not feasible. The following definitions were used: operating time was the time from first incision to wound closure, anaesthesia time was the time from induction to extubation, and length of stay was the number of days in hospital.

The study was approved by the METC Brabant Ethics Committee.

Statistical analysis

The statistical analysis was performed on the anonymized data using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented as frequencies, percentages, and/or range; numerical variables were presented as the mean ± standard deviation. Values were displayed in their respective tables. The normality of the data distribution for continuous variables was determined using a combination of the Kolmogorov–Smirnov test, skewness, kurtosis, and a visual examination of the distribution. Comparisons between

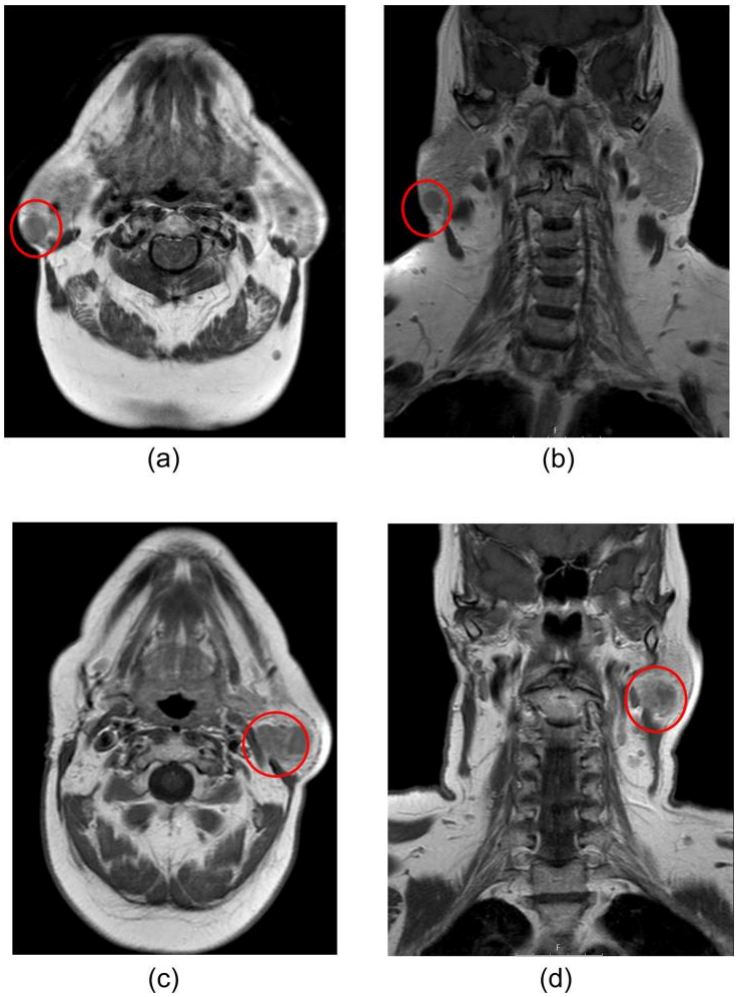

Fig. 1. (A) Ideal case for extracapsular dissection due to the superficial location and small size of the tumour, far from the facial nerve; axial view. (B) Coronal view of the tumour in Fig. 1A, ideal for extracapsular dissection due to the location in the posterior lower lobe. (C) Ideal case for superficial parotidectomy due to the deeper location and larger size; axial view. (D) Coronal view of the tumour in Fig. 1C.

continuous variables were done using the independent *t*-test (in the case of a normal distribution) or Mann–Whitney *U*-test (non-normal distribution). The categorical variables were coded using a variable dependent numerical coding system. For the categorical variables, comparisons were performed with Fisher's exact test or the Pearson χ^2 test. Statistical significance was considered with a P-value lower than 0.05. A line graph was drawn to depict the number of cases of each surgery type (ECD and SP) performed per year.

Results

A total of 161 parotidectomies met the inclusion criteria: 102 were performed by ECD (63.4%) and 59 by SP (36.6%) technique. There was a relative increase in the frequency of ECD during the study period (Fig. 2).

The sex distribution differed significantly between the two groups ($P = 0.033$), with male patients more frequently undergoing SP. There was no significant difference in median age at surgery, smoking status, or lesion side between the groups (Table 1). Lesion size was found to be significantly larger ($P = 0.007$) and the duration of follow-up significantly longer ($P = 0.036$) in the SP group. The 5-year disease-specific survival was 100%.

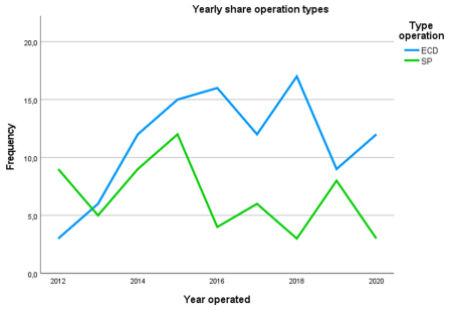

Fig. 2. Increase in relative frequency of extracapsular dissection (ECD) compared to superficial parotidectomy (SP) over time.

Pleomorphic adenoma was the most common lesion type, followed by Warthin tumour; other lesions were less common (Table 1). The frequency of positive margin status was significantly higher in the ECD group ($P = 0.037$); 24.5% of ECD cases had positive margins compared to 10.2% of SP cases.

Table 2 shows the comparison of reported intraoperative events between the ECD and SP groups. In 30.4% of ECD cases, the facial nerve was exposed due to proximity to the tumour; the nerve was left intact in these cases. The facial nerve was transected in two cases, both in the SP group. A statistically significant difference in greater auricular nerve transection was found, due to the method of surgery in the SP group, whereby the greater auricular nerve is transected after incision.

The preoperative FNAC diagnosis was confirmed by the final pathological diagnosis in 79.5% of the cases, as shown in Table 3. Preoperative FNAC was inconclusive in 16 cases. Four cases of cystic lesions were suspected, and one reactive lymph node. Four cases were suspected to be pleomorphic adenoma and two cases to be Warthin tumour, but could not be definitively identified.

Concerning the operation time, anaesthesia time, and length of hospital stay, statistically significant differences were found between the two procedures, as shown in Table 4. The operation time was found to be significantly shorter in the ECD group ($P < 0.001$). This also translated into a substantially shorter anaesthesia time ($P < 0.001$). The mean operation time in the ECD group was 69 ± 27 min, while this was 140 ± 23 min in the SP group. The anaesthesia time was 98 ± 28 min in the ECD group and 172 ± 27 min in the SP group. After the operation, patients in the ECD group were found to stay considerably shorter in the hospital ($P < 0.001$): a

Table 1. Demographic factors and features of the lesion in the extracapsular dissection (ECD) and superficial parotidectomy (SP) groups.

	ECD ($n = 102$) *n* (%)	SP ($n = 59$) *n* (%)	*P*-value
Age at surgery (years), mean (range)	57 (22–83)	58 (23–81)	0.714[a]
Sex			0.033[b]
Male	51 (50)	40 (67.8)	
Female	51 (50)	19 (32.2)	
Lesion side			0.744[b]
Right	54 (52.9)	29 (49.2)	
Left	48 (47.1)	30 (50.8)	
Smoking			0.8[b]
Current	39 (38.2)	25 (42.4)	
Former	17 (16.7)	10 (16.9)	
Histopathological diagnosis			
Pleomorphic adenoma	52 (51.0)	27 (45.8)	
Warthin tumour	41 (40.2)	22 (37.3)	
Myoepithelioma	1 (1.0)	4 (6.8)	
Basal cell adenoma	1 (1.0)	1 (1.7)	
Cystadenoma	0 (0)	2 (3.4)	
Lymphadenoma	0 (0)	1 (1.7)	
Lymphangioma	1 (1.0)	0 (0)	
Lympho-epithelial cyst	2 (2.0)	2 (3.4)	
Spindle cell lipoma	1 (1.0)	0 (0)	
Ductal salivary cyst	1 (1.0)	0 (0)	
Retention cyst	1 (1.0)	0 (0)	
Reactive lymph node	1 (1.0)	0 (0)	
Lesion size (cm^3), mean (range)	52 (1.4–380)	76 (3.4–390)	0.007[c]
Margin status			0.037[b]
Positive	25 (24.5)	6 (10.2)	
Negative	77 (75.5)	53 (89.8)	
Follow-up (years), mean (range)	4.19 (1–9)	4.98 (1–9)	0.036[a]

[a]Independent *t*-test.
[b]Pearson χ^2 test.
[c]Mann–Whitney *U*-test.

Table 2. Intraoperative events.

	ECD ($n = 102$) *n* (%)	SP ($n = 59$) *n* (%)	*P*-value
Greater auricular nerve transected	9 (8.8)	59 (100)	< 0.001[a]
Facial nerve branch transected	0 (0)	2 (3.4)	0.133[b]
Facial nerve branch exposed	31 (30.4)	59 (100)	< 0.001[a]
Retromandibular vein sacrificed	1 (1.0)	2 (3.4)	0.555[b]

ECD, extracapsular dissection; SP, superficial parotidectomy. aPearson $\chi 2$ test. bFisher's exact test.

Table 3. Comparison between preoperative FNAC and final pathology.

FNAC pathology	Number (%)	Final pathology	Number (%)
Pleomorphic adenoma	75 (46.6)	Pleomorphic adenoma	79 (49.1)
Warthin tumour	55 (34.2)	Warthin tumour	63 (39.1)
Likely pleomorphic adenoma	4 (2.5)	Myoepithelioma	5 (3.1)
Likely Warthin tumour	2 (1.2)	Basal cell adenoma	2 (1.2)
Basal cell adenoma	2 (1.2)	Cystadenoma	2 (1.2)
Myoepithelioma	1 (0.6)	Lymphadenoma	1 (0.6)
Spindle cell lipoma	1 (0.6)	Lymphangioma	1 (0.6)
Cystic lesion	4 (2.5)	Lympho-epithelial cyst	4 (2.5)
Reactive lymph node	1 (0.6)	Spindle cell lipoma	1 (0.6)
Classification not possible	16 (10)	Ductal salivary cyst	1 (0.6)
		Retention cyst	1 (0.6)
		Reactive lymph node	1 (0.6)

FNAC, fine needle aspiration cytology.

Table 4. Cost-effectiveness characteristics.

	ECD Mean ± SD	SP Mean ± SD	*P*-value
Operation time (min)	69 ± 27	140 ± 23	< 0.001[a]
Anaesthesia time (min)	98 ± 28	172 ± 27	< 0.001[a]
Length of stay (days)	0.7 ± 0.5	1.2 ± 0.5	< 0.001[a]

ECD, extracapsular dissection; SP, superficial parotidectomy; SD, standard deviation.
[a]Mann–Whitney *U*-test.

mean 0.7 ± 0.5 days, compared to 1.2 ± 0.5 days in the SP group.

The SP and ECD complication rates were comparable in all categories, except for facial nerve palsy ($P < 0.001$), temporary facial nerve palsy ($P < 0.001$), and haematoma formation ($P = 0.016$), which were more prevalent following SP (Table 5). Sixteen (27.1%) cases of temporary facial nerve weakness were reported in the SP group and four (3.9%) in the ECD group. Haematoma formation was present in nine (15.3%) SP cases and four (3.9%) ECD cases. No statistically significant difference in permanent facial nerve weakness was found ($P = 0.133$).

Discussion

In this study, significant differences were found between the SP and ECD groups in operation, anaesthesia, and hospitalization times. The mean operation time was significantly shorter in the ECD group; the longer surgery time in the SP group can be attributed to the time required for facial nerve identification. As a consequence, the mean anaesthesia time was also significantly reduced in the ECD group. Postoperatively the ECD group had a shorter hospital stay, with most patients in this group discharged on the same day with a drain in situ. They were seen later at an outpatient evaluation to remove the drain.

Kato et al.[15] reported mean operation and anaesthesia times of 83 min and 148 min, respectively, in their ECD patient group and 139 min and 213 min, respectively, in their SP patient group; the differences between the two groups were statistically significant. A significant difference in length of hospitalization was also reported in their study: 0.5 days for ECD patients compared to 1.3 days for SP patients. In another study, Barzan and Pin[7] reported a mean operation time of 60 min for ECD and 150 min for SP. These results are in line with the results found in the present study and indicate that SP surgery takes approximately double the time of ECD surgery. Therefore, the possibility of performing two ECD procedures in the time of one SP arises. A shorter hospitalization and procedure are likely to result in lower health care costs for the patient and society.[15] The real cost of total benign parotid gland tumour surgery as a primary endpoint is almost impossible to determine. No literature was found on this topic. Further studies with a more economic focus will be needed to express the cost-efficiency in real monetary terms.

Transient facial nerve palsy occurred in 27.1% of the SP cases and only 3.9% of the ECD cases ($P < 0.001$) in this study. This is comparable to the results of studies in the current literature, which have reported lower rates of transient and permanent facial nerve palsy with the ECD technique as well.[7,8,14,16] In the meta-analysis by Xie et al.[14] and study by Mantsopoulos et al.,[17] Frey syndrome was reported to be significantly less prevalent after ECD. In the present study, Frey syndrome occurred in one (1.0%) ECD case and three (5.1%) SP cases, with no

Table 5. Postoperative complication rates.

	ECD ($n = 102$) n (%)	SP ($n = 59$) n (%)	P-value
Frey syndrome (gustatory sweating)	1 (1.0)	3 (5.1)	0.140[a]
Facial nerve palsy			< 0.001[a]
Temporary	4 (3.9)	16 (27.1)	< 0.001[b]
Permanent	0 (0)	2 (3.4)	0.133[a]
Dysesthesia of the greater auricular nerve			0.214[a]
Temporary	4 (3.9)	1 (1.7)	0.653[a]
Permanent	5 (4.9)	7 (12)	0.125[a]
Seroma formation	0 (0)	2 (3.4)	0.133[a]
Sialocele formation	2 (2.0)	1 (1.7)	1[a]
Salivary fistula formation	1 (1.0)	3 (5.1)	0.140[a]
Haematoma	4 (3.9)	9 (15.3)	0.016[a]
Infection	1 (1.0)	2 (3.4)	0.555[a]

ECD, extracapsular dissection; SP, superficial parotidectomy.
[a]Fisher's exact test.
[b]Pearson χ^2 test.

significant difference between the groups ($P = 0.140$), due to small numbers. Haematoma formation occurred more in the SP procedure than in ECD ($P = 0.016$). The reported complications can adversely affect quality of life, which shows the benefit of ECD due to the lower incidence of complications. Quality of life should be considered in comparisons between the two surgical modalities.[18]

No cases of recurrence were identified in this study, probably due to the limited follow-up. Martin et al.[19] stated that due to the clinical nature of benign lesions, a follow-up time of at least 10 years is necessary to reliably evaluate the recurrence rate; this was not achieved in the present study. However, ECD has only recently been introduced at Elisabeth-TweeSteden Ziekenhuis to treat benign parotid lesions, although the relative share of ECD is increasing. Brennan et al.[9] and Mantsopoulos et al.[20] showed similar trends.

In the literature, recurrence has been reported to occur up to 20 years postoperative, with varying recurrence rates and significance for ECD and SP.[8,11,14,19,21,22] Foresta et al.[8] reported a higher recurrence rate in their SP group: 2.3 cases per 1000 person-years for SP compared to 0.2 cases per 1000 person-years in the ECD group. A recent meta-analysis by Martin et al.[19] also reported a higher recurrence rate in the SP group. However, in these meta-analyses, ECD was used for relatively smaller parotid gland tumours compared to SP, resulting in a selection bias, which was also found in the present study, and could be a reason for the higher recurrence rate for SP described in the studies above. As a result of the inherent differences between the two procedures, ECD might be assumed to have narrower margins due to the dissection close to the capsule.[7,19] However, this disadvantage is present in a large part of SP cases too, due to the close location of the tumour against the nerve caused by the size of the tumour, thus necessitating a dissection step.[7,8] Consequently, early removal is essential to prevent the need for the extra dissection step with higher chances of recurrence in SP. This way a cuff of healthy tissue is preserved, which prevents capsule rupture and potential spillage of the tumour contents – two of the reported risk factors for recurrence.[8,11,13,23] A barrier of healthy tissue also assists in less pseudopodia and tumour satellites being left behind.[13] In ECD, no common guideline exists regarding the required thickness of tissue left around the tumour, with different thicknesses being reported by different authors.[6,13,16]

Despite the aforementioned advantages with respect to the ECD procedure, not all cases can be treated with this technique. Location plays an important role, with tumours of any size in the posterior lower lobe being favourable for removal by ECD. Preauricular lesions favour SP due to the closer location to the facial nerve trunk. Moreover, tumours with an intrinsic higher chance of recurrence and tumours localized in the deeper lobe of the parotid gland are removed with SP or total parotidectomy, resulting in selection bias.[10,13]

Secondary ECD is primarily indicated for benign tumours, but potential false-negative preoperative assessment should be considered.[13] A strict diagnostic protocol is necessary to discriminate between benign and malignant tumours; a combination of ultrasound-guided FNAC, clinical examination (benign SGTs usually do not affect the facial nerve and are almost always freely mobile), and MRI should be used.[9,16]

A recent meta-analysis by Liu et al.[2] showed FNAC to have a sensitivity of 88% and specificity of 99.5% for discriminating between benign and malignant parotid tumours, with better results when ultrasound-guided. The Milan classification is a new tool to grade the degree of malignant potential of FNAC material from parotid tumours and is useful for determining the treatment protocol; a score of ≥5 represents a malignant lesion. This classification system was not applied in the cases included in the present study, but its more broad use in clinical practice and reporting of results in the literature is recommended.[24] The Milan classification has been implemented at Elisabeth-TweeSteden Ziekenhuis since 2018, with cases at risk of malignancy expedited for surgery.

In the present study, FNAC provided a correct final diagnosis in 79.5% of cases; no definitive diagnosis could be made in 20.5%. Therefore the situation arises where a tumour is preoperatively believed to be benign based on clinical (mobility, unilocularity, location, depth) and radiographic (well-defined margins, no enlarged lymph nodes) characteristics, but turns out to be malignant on postoperative histopathological analysis. If the course of

the disease was shown to be negatively altered after performing ECD on those malignant lesions masquerading as benign, the widespread use of the new treatment method would be limited. An alternative to FNAC is ultrasound-guided true core biopsy. A histological tissue sample may provide more diagnostic certainty than an aspirate obtained by FNAC. Mantsopoulos et al.[25] described no adverse effect on survival or postoperative quality of life in those cases where ECD was performed due to a false-negative preoperative report. Furthermore, the surgeon must be able to deviate from a planned ECD and switch to more invasive/traditional surgery if signs of malignancy are detected.[10,13]

This study has some limitations. No cases of recurrence were identified, probably related to the limited follow-up together with the slow-growing nature of these tumours. A selection bias was also identified, since SP was performed in the more complex cases and for larger tumours, and total parotidectomy cases were not included in the study. Facial nerve weakness, greater auricular nerve weakness, and Frey syndrome were reported on a clinical basis without the use of the House–Brackmann grading system, sensory index score, or starch iodine test, respectively.[19,26] In future studies, the aesthetic outcomes of the surgical incisions could also be investigated. The Milan classification was not used to grade the degree of malignant potential after FNAC. This classification could potentially be used in future studies to objectively grade the FNAC reports in institutions where FNAC is primarily used. As this was a retrospective file analysis, caution is needed when interpreting the reported results.

In this study, the extracapsular dissection technique showed better clinical outcomes as well as reduced complications when compared to the superficial parotidectomy technique in the selected cases. Therefore, after careful preoperative examination using FNAC, ultrasound, MRI, and clinical evaluation, the extracapsular dissection technique is a suitable alternative to superficial parotidectomy in well indicated and correctly located tumours, namely benign well-defined superficial mobile lesions, especially in the posterior lower lobe. Surgeons should, however, be able to switch between the two surgical modalities when intraoperative findings indicate the need for a more extensive debulking.

Funding

None.

Ethical approval

The study was approved by the METC Brabant Ethics Committee.

Competing interests

None.

Patient consent

Patient consent was not required.

References

1. Kochhar A, Larian B, Azizzadeh B. Facial nerve and parotid gland anatomy. *Otolaryngol Clin North Am* 2016;**49**:273–84.
2. Liu CC, Jethwa AR, Khariwala SS, Johnson J, Shin JJ. Sensitivity, specificity, and posttest probability of parotid fine-needle aspiration: a systematic review and meta-analysis. *Otolaryngol Head Neck Surg* 2016;**154**:9–23.
3. Dell'aversana Orabona G, Salzano G, Petrocelli M, Iaconetta G, Califano L. Reconstructive techniques of the parotid region. *J Craniofac Surg* 2014;**25**:998–1002.
4. Johns ME, Goldsmith MM. Incidence, diagnosis, and classification of salivary gland tumors. Part 1. *Oncology (Williston Park)* 1989;**3**:47–56. discussion 56, 58, 62.
5. Witt RL, Iro H, McGurk M. The role of extracapsular dissection for benign parotid tumors. *Curr Otorhinolaryngol Rep* 2014;**2**:55–63.
6. Klintworth N, Zenk J, Koch M, Iro H. Postoperative complications after extracapsular dissection of benign parotid lesions with particular reference to facial nerve function. *Laryngoscope* 2010;**120**:484–90.
7. Barzan L, Pin M. Extra-capsular dissection in benign parotid tumors. *Oral Oncol* 2012;**48**:977–9.
8. Foresta E, Torroni A, Di Nardo F, de Waure C, Poscia A, Gasparini G, Marianetti TM, Pelo S. Pleomorphic adenoma and benign parotid tumors: extracapsular dissection vs superficial parotidectomy—review of literature and meta-analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2014;**117**:663–76.
9. Brennan PA, Ammar M, Matharu J. Contemporary management of benign parotid tumours—the increasing evidence for extracapsular dissection. *Oral Dis* 2017;**23**:18–21.
10. Iro H, Zenk J. Role of extracapsular dissection in surgical management of benign parotid tumors. *JAMA Otolaryngol Head Neck Surg* 2014;**140**:768–9.
11. Albergotti WG, Nguyen SA, Zenk J, Gillespie MB. Extracapsular dissection for benign parotid tumors: a meta-analysis. *Laryngoscope* 2012;**122**:1954–60.
12. McGurk M, Thomas BL, Renehan AG. Extracapsular dissection for clinically benign parotid lumps: reduced morbidity without oncological compromise. *Br J Cancer* 2003;**89**:1610–3.
13. Deschler DG. Extracapsular dissection of benign parotid tumors. *JAMA Otolaryngol Head Neck Surg* 2014;**140**:770–1.
14. Xie S, Wang K, Xu H, Hua RX, Li TZ, Shan XF, Cai ZG. PRISMA—extracapsular dissection versus superficial parotidectomy in treatment of benign parotid tumors: evidence from 3194 patients. *Medicine* 2015;**94**:e1237.
15. Kato MG, Erkul E, Nguyen SA, Day TA, Hornig JD, Lentsch EJ, Gillespie MB. Extracapsular dissection vs superficial parotidectomy of benign parotid lesions: surgical outcomes and cost-effectiveness analysis. *JAMA Otolaryngol Head Neck Surg* 2017;**143**:1092–7.
16. Dell'Aversana Orabona G, Bonavolonta P, Iaconetta G, Forte R, Califano L. Surgical management of benign tumors of the parotid gland: extracapsular dissection versus superficial parotidectomy—our experience in 232 cases. *J Oral Maxillofac Surg* 2013;**71**:410–3.
17. Mantsopoulos K, Koch M, Klintworth N, Zenk J, Iro H. Evolution and changing trends in surgery for benign parotid tumors. *Laryngoscope* 2015;**125**:122–7.
18. Ciuman RR, Oels W, Jaussi R, Dost P. Outcome, general, and symptom-specific quality of life after various types of parotid resection. *Laryngoscope* 2012;**122**:1254–61.
19. Martin H, Jayasinghe J, Lowe T. Superficial parotidectomy versus extracapsular dissection: literature review and search for a gold standard technique. *Int J Oral Maxillofac Surg* 2020;**49**:192–9.
20. Mantsopoulos K, Scherl C, Iro H. Investigation of arguments against properly indicated extracapsular dissection in the parotid gland. *Head Neck* 2017;**39**:498–502.
21. Kanatas A, Ho MWS, Mücke T. Current thinking about the management of recurrent pleomorphic adenoma of the parotid: a structured review. *Br J Oral Maxillofac Surg* 2018;**56**:243–8.
22. Bradley PJ. The recurrent pleomorphic adenoma conundrum. *Curr Opin*

Otolaryngol Head Neck Surg 2018; **26**:134–41.
23. Witt RL. The significance of the margin in parotid surgery for pleomorphic adenoma. *Laryngoscope* 2002;**112**:2141–54.
24. Baloch ZW, Faquin WC, Layfield LJ. Is it time to develop a tiered classification scheme for salivary gland fine-needle aspiration specimens? *Diagn Cytopathol* 2017;**45**:285–6.
25. Mantsopoulos K, Velegrakis S, Iro H. Unexpected detection of parotid gland malignancy during primary extracapsular dissection. *Otolaryngol Head Neck Surg* 2015;**152**:1042–7.
26. Hegazy MAF, Nahas WE, Roshdy S. Surgical outcome of modified versus conventional parotidectomy in treatment of benign parotid tumors. *J Surg Oncol* 2011;**103**:163–8.

*Correspondence to: Department of Oral and Maxillofacial Surgery
ETZ Tilburg
Hilvarenbeekse Weg 60
5022GC Tilburg
the Netherlands.
E-mail: Robin.vanroose@ugent.be