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## Main Article

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## Abstract

**Objective.** In this study, we reviewed the post-operative complications in parotidectomy and its association with various patient, tumour and surgical factors.

**Methods.** All parotidectomies performed in our regional unit between 2013 to 2020 were identified. Electronic medical record and clinic letters were reviewed for any post-operative complications. A logistical regression model was applied on data collected on twelve patient factors, three tumour factors and four surgical factors.

**Results.** 379 cases of parotidectomy were identified in the eight-year study period. 55% ( $n = 210$ ) were documented with nine types of post-operative complications. This study identified age  $>80$  (odds ratio = 1.89,  $p = 0.018$ ), active smoker (odds ratio = 0.94,  $p = 0.018$ ), total parotidectomy approach (odds ratio = 1.77,  $p = 0.012$ ), longer operation time (odds ratio = 0.006,  $p = 0.015$ ) and hypertension (odds ratio = 1.23,  $p = 0.019$ ) were associated with a higher risk of facial nerve palsy. Predictive factors were also identified for auricular nerve numbness and Frey syndrome.

**Conclusion.** This study revealed the incidences and potential predictors of post-operative complications in parotidectomy. Notably, the grade of operator (consultants/ registrars) had no effect on the possibility of adverse outcome, reflecting patient safety was not compromised for training. These findings can be used in patient counselling and guide treatment options to minimise post-operative complications.

## Introduction

Parotidectomy is one of the most routinely performed surgeries of the head and neck. Due to the proximity of the parotid gland to various neurovascular structures in the facial region, a range of complications can be associated with this procedure. Traditionally, facial nerve palsy has been considered the most critical morbidity because of its significant impact on the patient's quality of life. Studies have attempted to identify risk factors associated with post-operative facial nerve palsy but have yielded contradictory or inconclusive results. It is important for clinicians to be aware of potential risk factors of common complications to reduce their incidences. In this study, parotidectomies completed in a specialist head-and-neck unit over a period of eight years were reviewed to elicit the incidences of post-operative morbidities. Various factors were analysed by a logistical regression model to explore if any are associated with the occurrence of post-operative morbidities in parotidectomy.

## Methods

### Study design and setting

The study was set in a tertiary head-and-neck specialist unit in the North of England. All parotidectomy cases completed from 2013 to 2020 were retrospectively identified and reviewed in the study. Parotidectomies with additional procedures completed in the same surgery were excluded to prevent overestimation of post-operative morbidities.

### Main outcome measures

Data were extracted from electronic medical records and clinic letters. The primary outcome was post-operative morbidities reported by patients up to the one-year follow-up period. Patient demographics, pre-operative co-morbidities, parotid lesion characteristics and operative characteristics were recorded (Table 1). Patient demographics included age, gender and body mass index (BMI). Co-morbidities analysed included hypertension, chronic obstructive pulmonary disease (COPD), diabetes mellitus, history of percutaneous coronary intervention, stroke, chronic kidney disease, active smoker, alcohol intake of more than 14 units a week and recent surgery within one year of the operation date.

**Table 1.** Potential associated factors of post-operative morbidities

Patient factor	Tumour factor	Operative factor
Gender	Stroke	Maximum dimension on radiological imaging
Age	Chronic kidney disease	Grade of primary surgeon
Body mass index	Facial nerve involvement on radiological imaging	Surgical approach
Hypertension	Histology	Total anaesthetic time
Chronic obstructive pulmonary disease	Active smoker	Neck dissection
Diabetes	Alcohol >14 units/week	
Percutaneous coronary intervention	Recent surgery <1 year	

Parotid lesion characteristics analysed were maximum dimension of lesion on pre-operative radiological imaging, facial nerve involvement with the lesion on radiological imaging and histology of lesion. Operative characteristics analysed were grade of operator (registrar or consultant), type of parotidectomy approach (partial, superficial, total), if neck dissection was performed and total anaesthetic time.

### Statistical analysis

Data were analysed using Jeffreys's Amazing Statistics Program 0.16.4<sup>1</sup> for logistic regression modelling. Pearson's chi-square test was used for analysis of independent variables on their association with each of the recorded post-operative morbidities. Odds ratios with their respective *p* values and 95 per cent confidence intervals (CIs) were recorded, with *p* < 0.05 defined as being statistically significant.

### Ethical consideration

This study was registered with the hospital clinical governance department and was compliant with local institutional ethical guidelines.

## Results

### Total number of parotidectomies completed

During the 8-year study period between 2013 and 2020, there were 402 cases coded as parotidectomy identified in the electronic database. Among these, 23 cases incorporated additional procedures and these were excluded from the study. These included one bilateral parotidectomy, one hemithyroidectomy, one parathyroidectomy, three oropharyngeal resections, three petrossectomies, five mastoidectomies and nine mandibulectomies. In total, 379 cases were included in the study.

### Incidences of post-operative morbidities

Complications were seen in 57.0 per cent (*n* = 216) of the parotidectomies in our study (Table 2). These included 62 cases (16.4 per cent) of facial nerve palsy less than 1 year, 40 cases (10.6 per cent) of facial nerve palsy more than 1 year, 61 cases (16.1 per cent) of greater auricular nerve hypoesthesia less than 1 year, 31 cases (8.2 per cent) of greater auricular nerve hypoesthesia more than 1 year, 23 cases (6.1 per cent) of salivary leak, 22 cases (5.8 per cent) of wound infection that required antibiotic treatment, 14 cases (3.7 per cent) of

Frey syndrome and 13 cases (3.4 per cent) of haematoma which required surgical drainage. The severity of facial nerve palsy was not included in this study; therefore, we must acknowledge that this could range from a partial palsy involving isolated marginal mandibular, buccal or temporozygomatic branch to complete palsy involving all branches of the facial nerve.

Among patients who developed post-operative morbidities, 43.5 per cent (*n* = 165) reported 1 complication, 12.1 per cent (*n* = 46) reported 2 complications and 1.3 per cent (*n* = 5) reported 3 complications. The most common co-occurring complications were facial nerve palsy and greater auricular nerve hypoesthesia, which was observed in 17 patients.

### Patient demographics and co-morbidities

Overall, 54.9 per cent of patients (*n* = 208) were female and 45.1 per cent (*n* = 171) were male. The median age was 59 years (range, 10–91 years). The median BMI was 29 kg/m<sup>2</sup> (range, 16.4–58.8 kg/m<sup>2</sup>). For pre-operative co-morbidities, 29.6 per cent of patients (*n* = 112) had hypertension, 4.7 per cent (*n* = 18) had COPD, 12.1 per cent (*n* = 46) had diabetes mellitus, 2.1 per cent (*n* = 8) had history of percutaneous coronary intervention, 5.5 per cent (*n* = 21) had previous strokes, 4.5 per cent (*n* = 17) had chronic kidney disease, 31.1 per cent

**Table 2.** Post-operative morbidities in the study group

Post-operative morbidity	Incidence ( <i>n</i> (%))
Facial nerve palsy <1 year	62 (16.4)
Partial parotidectomy	22
Superficial parotidectomy	30
Total parotidectomy	10
Facial nerve palsy >1 year	40 (10.6)
Partial parotidectomy	13
Superficial parotidectomy	12
Total parotidectomy	15
Greater auricular nerve hypoesthesia <1 year	61 (16.1)
Greater auricular nerve hypoesthesia >1 year	31 (8.2)
Salivary leak	23 (6.1)
Wound infection requiring antibiotics	22 (5.8)
Frey syndrome	14 (3.7)
Haematoma requiring drainage	13 (3.4)

**Table 3.** Histology of lesions

Histology	Incidence (n (%))
Malignant	70 (18.8)
– Squamous cell carcinoma	17
– Acinic cell carcinoma	13
– Lymphoma	7
– Carcinoma ex pleomorphic adenoma	5
– Merkel cell carcinoma	4
– Mucoepidermoid carcinoma	8
– Melanoma	4
– Adenoid cystic carcinoma	3
– Basal cell carcinoma	7
– Myoepithelial carcinoma	1
– Metastatic renal cell carcinoma	1
Benign	303 (81.2)
– Pleomorphic adenoma	166
– Warthin's tumour	86
– Recurrent pleomorphic adenoma	9
– Chronic parotiditis	8
– Salivary ductal cyst	12
– Lipoma	4
– Myoepithelioma	3
– Arteriovenous malformation	2
– Oncocytic adenoma	5
– Schwannoma	2
– Basal cell adenoma	5
– Reactive lymph node	1

( $n = 118$ ) were active smokers, 15.3 per cent ( $n = 58$ ) had alcohol intake more than 14 units/ week and 2.1 per cent ( $n = 8$ ) had recent surgery within 1 year.

### Tumour characteristics

The maximum dimensions of parotid lesions were recorded and the median maximum measurement was found to be 23 mm (range, 5–96 mm). In addition, 3.4 per cent of patients ( $n = 10$ ) had evidence of facial nerve involvement on radiological imaging, 18.8 per cent ( $n = 70$ ) of the lesions were malignant and 81.2 per cent ( $n = 303$ ) were benign (Table 3).

### Operative characteristics

A specialist registrar was documented as the primary surgeon for 34.3 per cent ( $n = 130$ ) of the study cases and consultant head-and-neck surgeons for the other 65.7 per cent ( $n = 249$ ) of cases. For parotidectomy approaches, 51.5 per cent of cases ( $n = 195$ ) were partial parotidectomies, 37.7 per cent ( $n = 143$ ) were superficial parotidectomies and 10.8 per cent ( $n = 41$ ) were total parotidectomies. The mean anaesthetic time was 146 minutes (35–645 minutes). Neck dissection was performed on 11.4 per cent ( $n = 41$ ) of cases. All study characteristics are illustrated in Table 4.

### Missing data

Radiological data such as the maximum dimensions of lesions and facial nerve involvement were missing in 22.7 per cent of study cases. The proportions of other missing data were 4.7 per cent for BMI and 1.6 per cent for histology. A logistic regression model was fitted to each of the 10 imputed datasets and the pooled results were used for inference.

### Logistic regression analysis of study variables and post-operative morbidity

Significant risk factors were found to be associated with facial nerve palsy, greater auricular nerve hypoesthesia and Frey syndrome (Table 5). For all facial nerve palsy, significant risk factors included anaesthetic time (odds ratio 1.005,  $p = 0.032$ ), age (odds ratio 1.021,  $p = 0.052$ ) (Figure 1), active smoker (odds ratio 2.297,  $p = 0.02$ ) and total parotidectomy (odds ratio 2.558,  $p < 0.001$ ); partial parotidectomy (odds ratio 0.963,  $p = 0.007$ ) was found to be a protective factor. For facial nerve palsy of more than 1 year, there was an additional risk factor of hypertension (odds ratio 1.23,  $p = 0.05$ ). For all greater auricular nerve hypoesthesia, risk factors included diabetes (odds ratio 4.786,  $p = 0.005$ ) and previous percutaneous coronary intervention (odds ratio 13.046,  $p = 0.034$ ). For Frey syndrome, risk factors included the size of lesion on pre-operative radiology (odds ratio 1.032,  $p = 0.053$ ).

### Discussion

This study reviewed incidences of post-operative morbidity in parotidectomy and elicited the respective statistically associated risk factors. Our case series were all obtained from a single centre. The strength of this is that a standardised patient journey from pre-assessment clinic, surgery, post-operative assessment to subsequent follow ups allowed us to present consistent data for a reliable statistical analysis. Overall, the documented morbidity rate in our case series was 55 per cent, which can seem high at first. However, considering studies that looked at single specific complications such as facial nerve palsy that were as high as 63 per cent, our morbidity rate accounting for all complications was comparatively low.<sup>2</sup>

### Post-operative facial nerve palsy

Although the extent of facial nerve palsies was not included due to the heterogeneity of documentation, cases of post-operative complete facial nerve palsies were rare in the study cohort. Most of the patients where detailed assessment of the facial nerve were available had only partial nerve palsy. Facial nerve palsy after parotidectomy has been reported to occur in 16–63 per cent of cases.<sup>2,3</sup> Our incidence of 27 per cent is therefore at the lower end of the spectrum. It should also be noted that 3.4 per cent of the cohort had pre-existing facial nerve involvement prior to the surgery. One reason for this could be that intra-operative electromyographic facial nerve monitoring is routinely utilised in our centre. Studies which have also routinely utilised this monitoring system reported similar rates of facial nerve palsy of around 20 per cent.<sup>2,4,5</sup>

Post-parotidectomy facial nerve palsy can be categorised into transient or persistent. However, there is no consensus on the duration of what should be classed as transient or otherwise. Current studies have defined short-term facial

**Table 4.** Study group characteristics

Factors	Post-operative complication, <i>N</i> = 216 (57.0%)	No post-operative complication, <i>N</i> = 163 (43.0%)	Overall, ( <i>N</i> = 379)
<b>Patient factors</b>			
– Sex (female) ( <i>n</i> (%))	111 (51.4)	97 (59.5)	208 (54.9)
– Age (median (range); years)	59 (10–90)	58 (11–91)	59 (10–91)
– Body mass index (median (range); kg/m <sup>2</sup> )	28.8 (16.4–45.1)	29 (17.6–58.8)	29 (16.4–58.8)
– Hypertension ( <i>n</i> (%))	66 (30.6)	46 (28.2)	112 (29.6)
– Chronic obstructive pulmonary disease ( <i>n</i> (%))	14 (6.5)	4 (2.5)	18 (4.7)
– Diabetes ( <i>n</i> (%))	28 (13.0)	18 (11.0)	46 (12.1)
– Percutaneous coronary intervention <i>n</i> (%)	5 (2.3)	3 (1.8)	8 (2.1)
– Stroke/transient ischaemic attack ( <i>n</i> (%))	7 (3.2)	14 (8.6)	21 (5.5)
– Chronic kidney disease ( <i>n</i> (%))	9 (4.2)	8 (4.9)	17 (4.5)
– Active smoker ( <i>n</i> (%))	74 (34.3)	44 (27.0)	118 (31.1)
– Alcohol intake >14 units/week ( <i>n</i> (%))	34 (15.7)	24 (14.7)	58 (15.3)
– Recent surgery (<6 months) ( <i>n</i> (%))	5 (2.3)	3 (1.8)	8 (2.1)
<b>Tumour factors</b>			
– Maximum dimension (median (range); mm)	24 (6–80)	21 (5–96)	23 (5–96)
– Facial nerve involvement( <i>n</i> (%))	8 (4.4)	2 (1.8)	10 (3.4)
– Histology ( <i>n</i> (%))			
– Malignant ( <i>n</i> (%))	45 (21.0)	25 (15.7)	70 (18.8)
– Benign ( <i>n</i> (%))	169 (79.0)	134 (84.3)	303 (81.2)
<b>Operative factors</b>			
– Operator grade ( <i>n</i> (%))			
– Registrar ( <i>n</i> (%))	85 (39.4)	45 (27.6)	130 (34.3)
– Consultant ( <i>n</i> (%))	131 (60.6)	118 (72.4)	249 (65.7)
– Surgical approach ( <i>n</i> (%))			
– Partial ( <i>n</i> (%))	97 (44.9)	98 (60.1)	195 (51.5)
– Superficial ( <i>n</i> (%))	87 (40.3)	56 (34.4)	143 (37.7)
– Total ( <i>n</i> (%))	32 (14.8)	9 (5.5)	41 (10.8)
– Operation time (median (range); min)	165.5 (46–645)	127 (35–379)	146 (35–645)
– Neck dissection ( <i>n</i> (%))	34 (16.0)	7 (4.3)	41 (11.4)

nerve palsy as symptoms duration ranging from 1 to 12 months post-operatively.<sup>6,7</sup> In our study, facial nerve palsy was categorised into shorter or longer than one year due to the local follow-up procedure.

Neck dissections and malignant parotid lesions have been reported to be associated with various extents of facial nerve palsy<sup>4,8</sup> that were not found to be statistically significant factors in our study. This could be attributed to the bigger sample size of our study and hence a higher number of facial nerve palsy cases for statistical analysis than the aforementioned studies.

In concordance with our data, advanced age has been shown to be associated with post-operative facial nerve palsy in other studies.<sup>7,9</sup> Some researchers have suggested this is because axonal regrowth of facial nerve is attenuated in older populations.<sup>7</sup> Similarly, studies have shown the extent of parotidectomy is associated with a higher incidence of facial nerve palsy, which is in agreement with our findings.<sup>8</sup> This is likely because the risk of stretching the facial nerve is higher in a more extended parotidectomy where more tissues are

resected. Although a malignant lesion in itself has not been found to be an associated factor in this study, it is potentially correlated with associated factors such as extent of parotidectomy and advanced age. This type of multicollinearity between variables can be mitigated by incorporating a larger sample size in a multivariate model in future studies. On the other hand, our data showed that patients who had undergone partial parotidectomy had a statistically lower chance of developing facial nerve palsy compared to cases of superficial or total parotidectomies. Studies which compared partial parotidectomy against more extended approaches in resecting benign parotid lesions have come to the same conclusion.<sup>10,11</sup>

Although the length of anaesthetic time in isolate could not be used as a pre-operative marker of risk, anaesthetic time has been shown to be directly correlated with morbidity after many types of surgery.<sup>12</sup> Prolonged operations are associated with surgical team fatigue, which can increase the risk of complications.<sup>13</sup> It is also likely that a longer anaesthetic time is indicative of a more complex procedure where the facial nerve has a higher chance of being injured intra-operatively.



**Table 5.** Logistic regression of significant associated risk factors

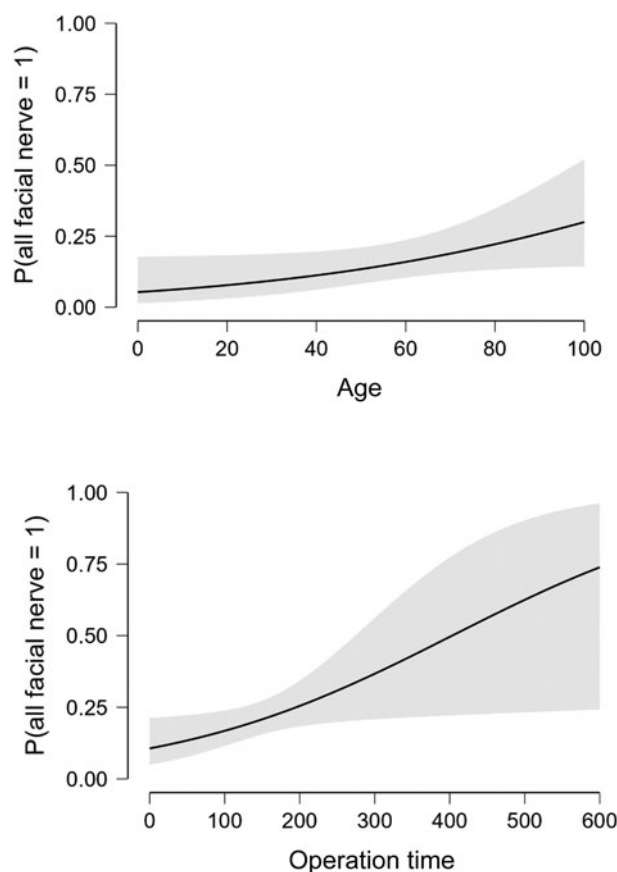
	Odds ratio	p value	95% confidence interval	
<b>Facial nerve palsy</b>				
Partial parotidectomy	0.963	0.007	-1.519	0.017
Anaesthetic time	1.005	0.032	0	0.010
Age	1.021	0.052	0	0.041
Active smoker	2.297	0.020	0.131	1.532
Total parotidectomy	2.558	<0.001	0.395	1.484
Hypertension	1.231	0.053	0.452	3.016
<b>Greater auricular nerve hypoesthesia</b>				
Diabetes	4.786	0.005	0.478	2.654
Percutaneous coronary intervention	13.046	0.034	0.189	4.948
<b>Frey syndrome</b>				
Maximum dimension of lesion	1.032	0.053	0	0.064

Smoking is a well-established risk factor for surgical complications.<sup>14</sup> We found that it is also associated with post-parotidectomy facial nerve palsy. Regional blood flow in small capillaries has been shown to be restricted in chronic smokers.<sup>15</sup> This microvascular dysfunction and the resultant impaired tissue perfusion has been suggested to be an underlying mechanism for complications in parotidectomy.<sup>16</sup> This could also explain how hypertension is an associated risk factor as it can likewise cause vascular endothelial dysfunction.<sup>17</sup>

### Greater auricular nerve hypoesthesia

Commonly, the greater auricular nerve is transected in parotidectomy to allow easier access to the parotid gland. In this group of patients, numbness of the upper pinna can be found in as high as 100 per cent of cases in the immediate post-operative period, decreasing to 50 per cent at 12-month follow-up.<sup>18</sup> Where possible, some centres have opted to preserve branches of the greater auricular nerve in hopes of minimizing post-operative hypoesthesia.<sup>19</sup> Other centres have shown this has no impact on reducing the rate of hypoesthesia.<sup>20</sup> Due to the heterologous format of operative notes in the eight-year study period, we were unable to determine if the greater auricular nerve was preserved in the respective cases reliably. Nonetheless, our large case numbers should offset the effect of nerve preservation not being included as a variable in the regression model.

- Due to the proximity of the parotid gland to various neurovascular structures in the facial region, a range of complications can be associated with parotidectomy
- Among the parotidectomies reviewed in the 8-year study period, the most common complications were facial nerve palsy that resolved within 1 year (16.4 per cent) and greater auricular nerve hypoesthesia that resolved within 1 year (16.1 per cent)
- Total anaesthetic time, patient age and active smoking were associated with a higher chance of developing post-operative facial palsy, and other risk factors were also identified for greater auricular nerve hypoesthesia and Frey syndrome
- Patients with the associated risk factors should be informed they could have a higher chance of developing certain complications when being consented for surgery



**Figure 1.** Inferential plot of logistic regression model on age and anaesthetic time with facial nerve palsy.

We found that patients with diabetes and a history of percutaneous coronary intervention are more likely to develop post-operative hypoesthesia. Diabetes can cause axonotmesis through microangiopathy and has been shown to prolong the course of Bell's palsy.<sup>21</sup> The same mechanism can impede the recovery process when the greater auricular nerve is inevitably injured. Patients who have undergone percutaneous coronary intervention have been shown to have an elevated level of circulating endothelial cells in the circulation, which is a marker for endovascular damage.<sup>22,23</sup> Systemic inflammation can also result from the mechanical trauma of the procedure and the co-morbid myocardial ischaemia.<sup>24</sup> The resultant loss of systemic endothelial function could affect functional recovery of the greater auricular nerve and put this group of patients more at risk of hypoesthesia.

### Frey syndrome

Symptomatic Frey syndrome has been reported to occur in 2–23 per cent of patients post-parotidectomy, which is in range of the 4 per cent incidence seen in our study.<sup>7,25</sup> However, there could be underestimation in the cohort due to the retrospective nature of the study. The specimen volume of the excised parotid tissue at the end of the surgery is linked with Frey syndrome, but these data were not available in our case series.<sup>7</sup> Consistent with our findings, one study showed tumour size to be a predictor in the development of Frey syndrome.<sup>26</sup> Logically, the shared mechanism behind these findings is that parasympathetic fibres would be more likely to be injured from a more extensive dissection for larger lesions.

### Limitation

Both radical and nerve-preserving parotidectomies were included in the study. However, due to the retrospective nature of the study, whether the facial nerve was sacrificed could not reliably be inferred from the operative record, therefore this was not included as a variable. There was also a lack of homogeneity in the documentation of the immediate post-operative ward round, therefore the House–Brackman scale of post-operative facial nerve palsy could not be reliably determined from the documentation included in the study. Future studies should be performed prospectively for more standardised data collection. Studies to investigate risk factors associated with post-operative morbidities in parotidectomy exist in the current literature but the findings have been variable. This is likely due to the heterogenous selection of cases between different centres. Similarly, although our findings have been consistent with other cited studies, our data and findings are limited to local patient selections.

### Conclusion

This study presented a consecutive parotidectomy case series over eight years to illustrate the incidences of post-operative morbidities and associated risk factors. These findings can guide clinicians in patient selection and lower the incidences of complications. Patients with the associated risk factors should also be informed they could have a higher chance of developing certain complications when being consented for surgery.

**Competing interests.** None declared

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