

Research Manuscript

Perioperative complications after parotidectomy using a standardized grading scale classification system. Impact on hospitalization stay.

Natacha Terlinden ¹, Marc Hamoir ^{1 2*}, Aline Van Maanen ³, Sandra Schmitz ^{1 2}

¹ Department of Head and Neck Surgery, King Albert II Cancer Institute, St Luc University Hospital, Brussels, Belgium.
natachaterlinden@gmail.com, marc.hamoir@uclouvain.be, sandra.schmitz@uclouvain.be

² Institut de Recherche Expérimentale et Clinique (IREC), Université Catholique de Louvain, Brussels, Belgium.
marc.hamoir@uclouvain.be, sandra.schmitz@uclouvain.be

³ Department of Biostatistics, King Albert II Cancer Institute, Brussels, Belgium. aline.vanmaanen@uclouvain.be

*Corresponding author: marc.hamoir@uclouvain.be

Abstract:

Background: Perioperative complications after parotidectomy are poorly studied and have a potential impact on hospitalization stay. The Clavien-Dindo classification of postoperative complications used in visceral surgery allows a recording of all complications, including a grading scale related to the severity of complication.

Methods: The cohort analyzed for perioperative complications is composed of 436 parotidectomies. classified into three types, four groups and three classes depending on extent of parotid resection, inclusion of additional procedures and pathology, respectively.

Results: Using the Clavien-Dindo classification, complications were reported in 77 % of the interventions. In 438 complications, 430 (98.2%) were classified as minor (332 grade I and 98 grade II) and 8 (1.8%) were classified as major (grade III). Independent variables affecting the risk of perioperative complications were duration of surgery (odds ratio = 1.007, p-value = 0.029) and extent of parotidectomy (odds ratio = 4.043, p-value = 0.007). Total/subtotal parotidectomy was associated with an increased risk of grade II-III complications [odds ratio = 2.866 (95% CI: 1.307-6.283), p-value = 0.009]. Hospital stay increased in patients with complications (p= 0.0064).

Conclusions: Use of Clavien-Dindo classification shows that parotidectomy is followed by a high rate of perioperative complications. Longer hospital stay is observed in patients with perioperative complications. Almost all complications are minor and have limited consequence on hospital stay.

Keywords: parotidectomy; postoperative complications; perioperative complications; salivary gland tumor; facial paralysis; hospital stay

1. Introduction

Parotidectomy is a surgical procedure typically performed in the surgical treatment of primary parotid gland tumors and cutaneous cancers of the head and neck with intraparotid lymph node metastases. The goal of surgery is to perform a complete tumor resection allowing local control with minimal morbidity mainly to the facial nerve.[1] While there is an abundant literature on long term complications of parotidectomy, little is known about the prevalence and the severity of early postoperative complications occurring during the perioperative period. The aim of this study is to retrospectively review perioperative complications in a consecutive series of patients who underwent parotidectomy in our department, using the Clavien-Dindo classification, a standardized grading scale classification system widely used in visceral surgery.[2]

2. Materials and Methods

The study was approved by the local ethical committee and followed the general recommendations of discretion to personal data as well as the Helsinki declaration.

2.1. Patients

The files of all patients who underwent parotidectomy in the department from January 2002 to March 2017 retrospectively reviewed. Four hundred thirty-eight surgical procedures were performed in 430 patients. Eight patients underwent two surgical procedures; three of them had a second intervention for tumor recurrence and five patients had bilateral interventions for: Whartin's tumors in three, Mikulicz syndrome in one and parotid lymph node metastasis from a skin carcinoma in one patient where the first parotidectomy was performed for a pleomorphic adenoma. Two patients were excluded from the analysis of complications for lack of data. Therefore, the cohort analyzed for postoperative complications is composed of 436 parotidectomies performed in 428 patients. Regarding the facial nerve function assessment specifically, eight patients with preoperative facial nerve paralysis were excluded from the analysis. Facial nerve paralysis was consecutive to previous parotidectomy performed elsewhere in three, primary carcinoma in four and previous stroke in one. The American Society of Anesthesiologists (ASA) physical status classification is a grading system based on subjective assessment of patient's overall health to determine the physical status of preoperative patients for an anesthetic risk assessment. In 1963, the American Society of Anesthesiologists (ASA) adopted a five-category physical status classification system. The ASA score, routinely used during the preoperative anesthesiology consultation, was initially based on five classes (I to V): 1. Healthy person, 2. Mild systemic disease, 3. Severe systemic disease, 4. Severe systemic disease that is a constant threat to life, 5. Moribund person who is not expected to survive without the operation. Later, a sixth category was included for declared brain-dead organ donors.[3] The Body Mass Index (BMI) was recorded preoperatively according to the correlation of BMI with postoperative complications frequently reported in surgical procedures.[4-7]

Parotidectomies were classified into three types depending on extent of parotid resection. Type 1 included partial resection of the superficial parotid where the main trunk but not all branches of the facial nerve were identified; type 2 included complete resection of the superficial parotid, identifying all branches of the facial nerve; type 3 included resection of the superficial parotid and the deep lobe, partly or totally (subtotal and total parotidectomy), requiring complete release and elevation of the main trunk and branches of the facial nerve.

Surgical procedures were classified in 4 groups based on the inclusion of additional procedures to parotidectomy. Group I included parotidectomy alone, group II included parotidectomy combined

with neck dissection, group III included parotidectomy combined with resection of a non-parotid tumor and group IV included parotidectomy combined with neck dissection and resection of a non-parotid primary tumor. Finally, after definitive pathological analysis, three classes were identified. Class 1 included benign tumors and inflammatory diseases, class 2 included primary parotid malignant tumors and intraparotid lymph node metastases from non-parotid cancers, class 3 included non-parotid primary tumors for which parotidectomy has been performed to facilitate tumor access or to achieve clear margins (table 1).

Extent of Parotid Resection	Type 1. Partial superficial parotidectomy
	Type 2. Complete superficial parotidectomy
	Type 3. Subtotal / Total parotidectomy
Overall extent of surgical procedure	Group 1. Parotidectomy alone
	Group 2. Parotidectomy + neck dissection
	Group 3. Parotidectomy + resection of non-parotid tumor
	Group 4. Parotidectomy + neck dissection + resection of non-parotid tumor
Pathology	Class 1. Benign tumors and inflammatory diseases
	Class 2. Malignant tumors and metastatic lymph nodes
	Class 3. Non parotid tumors

Table 1: Classification of surgical procedures according to extent of parotidectomy, extent of overall surgical procedure and pathology.

The perioperative period was defined as the interval from the date of surgery to either the date of discharge from the hospital or 30 days after surgery, whichever occurred later. All perioperative complications, namely those reported during hospital stay and in outpatient clinic, from the day of the surgical procedure to the 30th postoperative day were recorded. A postoperative complication was defined as any deviation from the normal postoperative course not better explained by a previous medical condition, not inherent to the procedure or hospital course, and not reflective of the underlying pathophysiology of the primary diagnosis. Complication severity was retrospectively graded following the revised Clavien-Dindo classification.[8] Minor complications requiring no or minimal therapeutic intervention were classified as grades I and II, respectively. Major complications requiring surgical intervention or intensive care or resulting in death were classified as grades III, IV, and V, respectively (table 2). The House-Brackmann grading system was recorded in the medical files for grading the facial nerve dysfunction.[9] During the major part of the study period, intraoperative facial nerve monitoring was only used in reinterventions and when difficulty identifying the facial nerve was anticipated. Facial nerve monitoring was routinely used from March 2015. As the distinction between seroma and sialocele was often difficult to establish retrospectively, both have been gathered under a single name.

Grade	Definition
-------	------------

Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside.
Grade II	Requiring pharmacological treatment with drugs other than those allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included.
Grade III	Requiring surgical, endoscopic, or radiological intervention.
IIIa	Intervention not under general anesthesia.
IIIb	Intervention under general anesthesia.
Grade IV	Life-threatening complication (including CNS complications)* requiring IC/ICU management.
IVa	Single organ dysfunction (including dialysis).
IVb	Multiorgan dysfunction.
Grade V	Death of a patient.

Abbreviations: CNS, central nervous system; IC, intermediate care; ICU, intensive care unit.
*Brain hemorrhage, ischemic stroke, and subarachnoid bleeding, but excluding transient ischemic attacks.

Table 2: Clavien–Dindo classification of surgical complications

2.2. Statistics

Usual statistical descriptive summaries were tabulated for patients characteristics (patient age at surgery, gender, BMI), medical history (smoking status, cardiovascular and diabetes history, ASA score, previous radiotherapy, previous parotidectomy), type of surgery (length, extent of parotidectomy, additional procedures, flap, use of monitoring, drainage), disease information (histological type and pathological information). The prevalence of short-term complications and Clavien-Dindo grades were reported. Continuous data were summarized using descriptive statistics (mean, standard deviation, median, minimum and maximum values). Categorical data were summarized using frequencies and percentages. Analyses were based on observed cases only. Frequency of missing data were reported and no imputation was done.

In order to identify potential risk factors associated with short-term complications, logistic regression analysis was used based on the proportional odds model.[10] Univariate analyses were first conducted in order to select factors to be entered into the multivariate model. Variables favoring more severe complications were analyzed by pooling together grade II and grade III complications. Then, the final multivariate model was obtained using a backward selection among factors significantly ($p<0.20$) associated with short-term complication. Odds ratios with associated 95% Wald confidence limits were presented together with the corresponding p-value. For continuous explanatory variables, the odds ratio corresponded to a unit increase in the risk factors.

Due to the non-normality distribution of the duration of hospital stay distribution, the impact of perioperative complications on the duration of hospital stay was analyzed with a non-parametric test (Mann Whitney U test) comparing the number of days of hospital stay between patients with

complications and patients without complication respectively. The lengths of hospital stays were ranked according to their position when classified in ascending order. The average score was the sum of the ranks of hospital stays divided by the number of interventions. A p-value < 0.05 was considered to be statistically significant.

3. Results

3.1. Patient and surgical procedure characteristics

The cohort under analysis included 428 patients with a median age of 55.4 years (range: 0.3 - 99.9 years) who underwent 436 surgical procedures. The series was composed of 202 females (47.2%) and 226 male patients (52.8%). The median BMI was 25 kg/m² (range: 15.2 - 53.1 kg/m²). Active smoking was reported in 143 patients (33.4%). Preoperative ASA score was reported as ASA I in 93 patients (22.1%), ASA II in 285 patients (67.7%) and ASA III in 43 patients (10.2%). In 7 patients, the ASA score was not available.

Regarding the extent of parotidectomy, type 1 was performed in 88/436 (20.2%) procedures, type 2 in 229 (52.5%) procedures and type 3 parotidectomy in 106 (24.3%) procedures. Thirteen interventions (3.0%) were not classified for lack information.

Twenty interventions (4.6%) were defined as re-interventions because performed in patients with local recurrence after previous surgery performed for pleomorphic adenoma in 14 patients and malignant tumor in six.

Regarding the extent of surgical procedures, group I were performed in 347 (79.6%) interventions, group II in 27 interventions (6.2%), group III in 32 (7.3%) and group IV in 30 interventions (6.9%) of surgical interventions. Overall, in addition to parotidectomy, neck dissections including at least two levels were performed in 57/436 (13.1%) interventions. Selective neck dissections II-III were performed in 28 cases (6.4%), II-IV in 7 (1.6%), II - V in 19 (4.3%) when modified radical neck dissections I-V were performed in only 3 cases (0.1%). In addition to parotidectomy, resections of a non-parotid tumors were performed in 62 cases (14.2%), consisting in resection of primary non-parotid tumors in 59/62 (95.2%) when these combined procedures were not directly related to parotidectomy (e.g., benign skin tumor) in the remaining three (4.8%). At the end of the procedure, a SMAS flap was performed in 311/436 procedures (71.3%). Drainage of the surgical site was provided by vacuum suction drains in 314 procedures (75.5%) and non-suction open drains in 102 (24.5%) when the information was missing in 20 (4.6%).

From 2006, the duration of the surgery was precisely recorded. Accurate duration was available in 310 operations including 264 group I procedures. The median operating time for all procedures was 140 minutes (52 - 345 minutes) and 130 minutes (52-325 minutes) for group I procedures specifically.

After pathological analysis, 283/436 specimens (64.9%) were classified as class 1 (benign and inflammatory). Among the benign tumors, two distinct tumors with different histology were diagnosed in the resected parotid specimens in two patients, resulting in a final number of 269 benign tumors. Sixteen patients (3.7%) were operated for various inflammatory disease included sialadenitis, granulomatous reactions, ductal ectasia and benign adenopathy. Malignant disease was diagnosed in 103/436 specimens (23.6%) classified class 2 including 56 malignant tumors of the parotid gland (12.8%) and 47 intraparotid malignant lymph nodes from non-parotid cancer (10.8%), metastasis from head and neck cutaneous cancers in most of them and lymphomas. Last, 50 non-parotid tumors where parotidectomy was performed to obtain clear margins were included in class

3. The parotid gland was reported as non-invaded in 38/50 (76%) and invaded in 12/50 (24%). Detailed tumor characteristics and distribution are reported in table 3.

Pathology	n	%
Total	438	100
Class 1: Benign	285	65
INFLAMMATORY DISEASES	16	
BENIGN TUMORS	269	
Pleomorphic Adenoma	160	
Whartin's tumor (cystadenolymphoma)	82	
Basal cell adenoma	8	
Oncocytoma	7	
Benign cyst	6	
Lipoma	4	
Cavernous lymphangioma	1	
Hematoma	1	
Class 2 : Malignant tumors	103	23.6
PRIMARY MALIGNANT TUMORS	56	12.8
Acinic cell carcinoma	13	
Mucoepidermoid carcinoma	11	
Adenoid cystic carcinoma	7	
Carcinoma ex-pleomorphic adenoma	8	
Salivary duct carcinoma	6	
Adenocarcinoma	5	
Myoepithelial carcinoma	2	
Sebaceous carcinoma	2	
Clear cell carcinoma	1	
Squamous cell carcinoma	1	
INTRAPAROTID LYMPH NODE METASTASES FROM NON- PAROTID TUMORS & LYMPHOMAS	47	10.8
Cutaneous Squamous cell carcinoma	16	
Cutaneous Melanoma	16	
Cutaneous Merkel cell carcinoma	6	
Cutaneous Sebaceous carcinoma	3	
Lymphoma	5	
Breast lobular carcinoma	1	

Class 3: Non primary tumors of the parotid	50	11.5
Skin cancers	42	
Skin cancers -Parotid not invaded	37	
Skin cancers - Parotid invaded	5	
Cutaneous Lymphoma (parotid not invaded)	1	
Sarcomas (parotid invaded)	4	
Cheek adenocarcinoma (parotid invaded)	1	
Plexiform neurofibroma (parotid invaded)	1	
Heterotopic central nervous tissue (parotid invaded)	1	

Table 3 : Pathology characteristics. Abbreviations : n= number, % = percentage

3.2. Complications

General complications (e.g. arterial hypertension, pressure ulcers,...) were reported in 18/436 (4.1%) procedures. Local complications attributed to the anesthetic procedure were reported in < 0.1% (3/438) procedures as follows: pharyngeal oedema,1; epistaxis,1, and dental dislocation,1. Only complications related to the surgical procedures were analyzed using the Clavien-Dindo classification. No complication was reported in 100/436 procedures (22.9%) when one or more local complications were reported in 336 procedures (77.1%) with an overall number of 438 reported complications (table 4). Clavien-Dindo grade I complications were reported in 244 procedures (72.6%), grade II in 85 interventions (25.3%), and grade III after 7 interventions (2%). According to the Clavien-Dindo classification, any facial nerve dysfunction regardless to the severity, observed during the first 30 postoperative days, was reported. Even patients with slight facial nerve dysfunction (grade II House-Brackmann) observed during the first postoperative days with rapid complete recovery after a few days were registered. Overall, a House-Brackmann grade II to V facial nerve dysfunction was observed after 264/428 of the interventions (61.7%). Facial nerve dysfunction was classified as Clavien-Dindo grade I in 211 procedures (79.9%) and grade II in 53 procedures (20.1%) respectively. In 142 interventions (32.6%), wound healing disorders were reported. Among an overall number of 174 wound healing disorders (a few patients experienced several healing disorders), there were 83 seromas, 43 scar dehiscence, 27 local infections, 16 hematomas and five transient salivary fistulae. Seventy seromas reported were classified as grade I (84.3%) and 13 as grade II (15.7%). Regarding scar dehiscences, 36 were staged as grade I (83.7%) and seven as grade II (16.3%). Among local infections, three were classified grade I (11.1%), 23 were grade II (85.2%) because requiring antibiotics and one was staged grade IIIb (3.7%). Seven hematomas, were classified as grade I (43.7%), two were grade II (12.5%) and seven (43.7%) were grade IIIb, because requiring surgical intervention. All five salivary fistulae were grade I (table 4).

Local complications	Grade (Clavien-Dindo)			
	I	II	IIIa	IIIb

Facial nerve impairment	264	211	53		
Seroma/Sialocele	83	70	13		
Dehiscence	43	36	7		
Infection	27	3	23		1
Hematoma	16	7	2		7
Salivary fistula	5	5			
TOTAL	438	332	98		8

Table 4: Local perioperative complications after parotidectomy according to Clavien-Dindo classification

Overall, in 438 reported complications, 332 were grade I (75.8%), 98 were grade II (22.8%), and 8 (1.8%) were grade IIIb. All grade IIIb complications required surgical intervention to control hematomas and abscess. Four hundred thirty complications (98.2%) were considered as minors (grade I and II) when only 8 complications (1.8%) were considered as majors. No grade IV-V complications were reported.

In univariate logistic regression analysis, type 2 parotidectomy was significantly associated with a higher risk of complications compared to type 1 parotidectomy [odds ratio 1.808 (95% CI: 1.064-3.070), p-value = 0.028]. Type 3 parotidectomy was also significantly associated with a higher risk of complications compared to type 1 parotidectomy [odds ratio 4.934 (95% CI: 2.307-10.555), p value > 0.001]. Duration of the procedure was significantly associated with a higher risk of complications, increasing by a factor of 1.010 per additional minute [odds ratio 1.010, p-value <0.001] (table 5). In multivariate analysis, independent variables affecting significantly the risk of perioperative complications were the duration of the procedure, increasing the risk of complications by a factor of 1.007 for each additional minute (odds ratio = 1.007, p-value = 0.029) and extension of parotidectomy. Type III parotidectomy was associated with an increased risk of complications by 4 times compared to type I parotidectomy (odds ratio = 4.043, p-value = 0.007) (table 6).

Variable	Odds ratio (95% CI)	p-value
Age at surgery: as a continuous variable	1.000 (0.988-1.012)	0.987
Gender : Female/Male	1.286 (0.819-2.019)	0.275

Variable	Odds ratio (95% CI)	p-value
ASA score: ASA 2 vs 1	0.907 (0.516-1.594)	0.733
ASA score: ASA 3 vs 1	0.797 (0.342-1.855)	0.599
BMI (kg/m ²): as a continuous variable	0.991 (0.949-1.036)	0.699
Active smoking: y/n	0.733 (0.462-1.163)	0.187
Previous head & neck RT: y/n	1.502 (0.324-6.969)	0.603
Previous parotid surgery: y/n	2.773 (0.632-12.160)	0.176
Group 2 (Parotidectomy + ND) vs Group 1 (Parotidectomy alone)	2.358 (0.692-8.036)	0.170
Group 3 (Parotidectomy + other T res.) vs Group 1	0.753 (0.335-1.694)	0.493
Group 4 (Parotidectomy + ND + other T res.) vs Group 1	0.688 (0.303-1.562)	0.371
Type 2 (complete superficial) vs Type 1 (partial superficial)	1.808 (1.064-3.070)	0.028
Type 3 (Subtotal/Total) vs Type 1	4.934 (2.307-10.555)	<0.001
Drainage: Active Suction vs n	0.832 (0.486-1.423)	0.502
Neuromonitoring: y/n	0.950 (0.530-1.703)	0.864
SMAS flap: y/n	1.392 (0.555-3.490)	0.481
Surgery duration: as a continuous variable	1.010 (1.004-1.016)	<0.001
Class 2 (Primary malignant parotid T) vs Class 1 (Benign parotid T)	0.857 (0.504-1.460)	0.571
Class 3 (Non-parotid primary T) vs Class 1	0.707 (0.358-1.393)	0.316

Table 5: Univariate logistic regression with selected variables for local complications (surgical procedures: n = 436). Variables with a p-value < 0.2 selected for multivariate logistic analysis are in colored lines. Abbreviations: y: yes, n: no, ASA: American Society of Anesthesiologists, BMI: Body Mass Index, RT: radiotherapy, T: tumor, res.: resection, ND: neck dissection, SMAS: Superficial Musculoaponeurotic System

MULTIVARIATE LOGISTIC REGRESSION TABLE		
Factor	Odds ratio (95% CI)	p-value
Surgery duration as a continuous variable	1.007 (1.001-1.014)	0.029
Extent of parotidectomy : Type 2 vs Type 1	1.329 (0.694-2.547)	0.391
Extent of parotidectomy : Type 3 vs Type 1	4.043 (1.476-11.072)	0.007

Table 6 : Multivariate logistic regression for local perioperative complications after parotidectomy (surgical procedures: n = 436)

Then, the analysis was focused on the risk of perioperative facial paralysis. Because facial nerve monitoring was routinely used from March 2015, neuromonitoring was used in only 76/436 interventions (17.4%). In univariate analysis, female gender was significantly associated with an increased risk of facial paralysis [odds ratio 1.515 (95% CI: 1.022-2.247), p-value = 0.039], group IV parotidectomy (+ neck dissection and resection of a non-parotid tumor) was associated with a lower risk of facial paralysis compared to group I parotidectomy (alone) [odds ratio 0.428 (95% CI: 0.198-0.924), p-value = 0.031], type 2 parotidectomy was associated with an increased risk of facial paralysis compared to type 1 parotidectomy [odds ratio 1.986 (95% CI: 1.206-3.272), p-value = 0.007], and type 3 parotidectomy was associated with a much higher risk of facial paralysis compared to type 1 parotidectomy [odds ratio 7.236 (95% CI: 3.659-14.309), p-value <0.001]. Duration of the procedure increased the risk of facial paralysis by a factor of 1.009 for each additional minute [odds ratio 1.009 (95% CI: 1.004-1.015), p-value <0.001] (table 7). In multivariate analysis, the duration of surgery increased the risk of facial paralysis by a factor of 1.009 for each additional minute [odds ratio = 1.009 (95% CI: 1.003-1.015), p-value = 0.002] and the risk of postoperative facial paralysis was 3.7 times higher after type 3 parotidectomy than after type 1 parotidectomy [odds ratio = 3.707 (95% CI: 1.598-8.598), p-value = 0.002] (table 8).

Variable	Odds ratio (95% CI)	p-value
Age et surgery: as a continuous variable	0.998 (0.987-1.008)	0.656
Gender: Female/Male	1.515 (1.022-2.247)	0.039

Variable	Odds ratio (95% CI)	p-value
ASA score: ASA 2 vs 1	0.874 (0.537-1.423)	0.588
ASA score: ASA 3 vs 1	0.746 (0.354-1.571)	0.440
BMI (kg/m ²): as a continuous variable	0.965 (0.929-1.003)	0.072
Active smoking: y/n	0.702 (0.467-1.057)	0.090
Previous head & neck RT: y/n	1.893 (0.505-7.093)	0.344
Previous parotid surgery: y/n	2.072 (0.664-6.465)	0.210
Group 2 (Parotidectomy + ND) vs Group 1 (Parotidectomy alone)	2.544 (0.936-6.911)	0.067
Group 3 (Parotidectomy + other T res.) vs Group 1	0.839 (0.398-1.768)	0.644
Group 4 (Parotidectomy + ND + other T res.) vs Group 1	0.428 (0.198-0.924)	0.031
Type 2 (complete superficial) vs Type 1 (partial superficial)	1.986 (1.206-3.272)	0.007
Type 3 (subtotal/total) vs Type 1	7.236 (3.659-14.309)	<0.001
Drainage: Active suction vs n	0.682 (0.425-1.096)	0.114
Neuromonitoring: y/n	0.803 (0.484-1.331)	0.394
SMAS flap: y/n	1.309 (0.556-3.082)	0.538
Surgery duration: as a continuous variable	1.009 (1.004-1.015)	<0.001
Class 2 (Primary malignant parotid T) vs Class 1 (Benign parotid T)	1.061 (0.569-1.979)	0.853
Class 3 (Non-parotid primary T) vs Class 1	0.713 (0.446-1.141)	0.159

Table 7: Univariate logistic regression with selected variables for occurrence of facial paralysis as perioperative complication (surgical procedures: n = 428). Variables with a p-value < 0.2 selected for multivariate logistic analysis are in colored lines. Abbreviations: y: yes, n: no, ASA: American Society of Anesthesiologists, BMI: Body Mass Index, RT: radiotherapy, T: tumor, res.: resection, ND: neck dissection, SMAS: Superficial Musculoaponeurotic System

MULTIVARIATE LOGISTIC REGRESSION TABLE		
Factor	Odds ratio (95% CI)	p-value
Surgery duration: as a continuous variable	1.009 (1.003-1.015)	0.002

MULTIVARIATE LOGISTIC REGRESSION TABLE		
Factor	Odds ratio (95% CI)	p-value
Extent of parotidectomy: Type 2 vs Type 1	1.110 (0.601-2.050)	0.738
Extent of parotidectomy: Type 3 vs. Type 1	3.707 (1.598-8.598)	0.002

Table 8: Multivariate logistic regression for facial paralysis occurrence after parotidectomy (surgical procedures: n = 428)

Similar analysis was focused on wound healing complications. In univariate analysis, none of the variables analyzed was significantly associated with a higher rate of healing disorders (table S1). After selection of variables with a p-value <0.2 for a multivariate logistic regression analysis, higher BMI was found as independent prognostic factor with a risk increased by a factor of 1.050 for each additional BMI unit [odds ratio = 1.050 (95% CI: 1.001-1.101), p-value = 0.048] (table S2).

A same analysis was performed on the occurrence of postoperative seromas specifically. In univariate analysis, none of the variables analyzed was significantly associated with a higher rate of seromas (table S3). After selection of variables with a p-value <0.2 for multivariate analysis, use of active suction drains was found as an independent prognostic factor associated with a higher risk of seroma [odds ratio = 3.797 (95% CI: 1.117 -12.901), p-value = 0.033] (table S4).

Next, the relation between selected variables and the severity of complications, pooling together grade II and grade III complications, was analyzed. In univariate analysis, older age was significantly associated with a little lower risk of > grade I complications [odds ratio = 0.981 (95% CI: 0.968-0.994), p-value = 0.004]. The extent of parotidectomy was significantly associated with a higher risk of > grade I complications [odds ratio = 2.963 (95% CI: 1.362-6.444), p-value = 0.006] (table S5). In multivariate analysis, the extent of parotidectomy was an independent prognostic factor significantly associated with a higher risk of grade II-III complications. Type 3 parotidectomy increased the risk of grade II-III complications by almost 3 times than type 1 parotidectomy [odds ratio = 2.866 (95% CI: 1.307-6.283), p-value = 0.009]. Older age was confirmed as independent prognostic factor for a slightly lower risk of > grade I complications [odds ratio = 0.981 (95% CI: 0.968-0.994), p-value = 0.006]. (table S6).

3.3. Hospital stay

Finally, the correlation between occurrence of complications and duration of hospital stay was analyzed. Overall, the median hospital stay was 3 days (1-43 days, mean: 3.21 days). In surgical procedures without complication (n=100), the median hospital stay was 2 days (2-13 days, mean: 2.94 days) (figure S1). In surgical procedures followed by complication(s) (n=336), the median hospital stay was 3 days (1-43 days, mean: 3.29 days) (figure S2). One patient stayed in hospital for 43 days because of complications from chronic lung disease unrelated to parotid surgery.

The median hospital stay in patients with and without postoperative transient facial paralysis was similar: 3 days (1-43 days, mean: 3.30 days) vs. 3 days (1-13 days, mean: 2.88 days) respectively (figures S3 and S4). The median hospital stay in patients with and without healing disorders was similar: 3 days (1-15 days, mean: 2.97 days) vs. 3 days (1-43 days, mean: 3.33 days) respectively

(figures S5 and S6). The median hospital stay in patients with and without seroma was 2 days (2-8 days, mean: 2.75 days) vs. 3 days (1-43 days, mean: 3.32 days) respectively (figures S7 and S8).

A non-parametric Mann Whitney U test analysis, comparing the number of days of hospital stay between patients with and without complications, showed that hospital stay was significantly increased in patients who had perioperative complications ($p=0.0064$). A longer hospital stay was observed in patients with postoperative facial paralysis ($p=0.0007$) when a shorter hospital stay was observed in patients with postoperative seroma compared with patients without postoperative seroma ($p=0.0063$). (table 9)

Perioperative local complications	p-value (Wilcoxon Mann Whitney U test)	Surgery with complications		Surgery with no complication	
		n	Average score	n	Average score
All	0.0064	336	226.81	100	190.59
Facial paralysis only	0.0007	264	229.29	164	190.69
Wound healing (all)	0.1102	142	205.70	294	224.680
Seromas only	0.0063	83	187.04	353	225.90

Table 9: Non-parametric Mann Whitney U test comparing lengths of hospital stays between parotidectomies with and without perioperative complications. All= overall complications (n = 436: analysis of all complications, wound healing disorders and seromas; n= 428: analysis of facial paralysis only)

4. Discussion

In head and neck surgery, the heterogeneity of tumors and management induces large variance in outcome data among the institutions. [11,12] Registration of complications in surgery is an important method used for quality improvement. Depending on the exceedingly variable definition and reporting of complications, the registered complication rate may considerably differ. Using the same definition but changing the interpretation of the definition of complications, Veen et al shown a dramatic increase in the total number of registered complications with the implementation of a fully automated registration system and a patient-centred-way of registering complications registering all adverse-events, not only related to the surgical procedure.[13] In addition, the fear that a high rate of complications could be interpreted in the medical community as evidence of poor quality of care contributes to inaccurate reporting of adverse events. [12] A consensus is clearly needed to report surgical complications using uniform definitions and registration system to assure reliable outcome data in a standardized and reproducible way, building a strong basis for comparison.

In 2004, Dindo et al. proposed a straightforward classification system to standardize surgical complications. [2,8] The Clavien-Dindo classification of postoperative complications, commonly used in general and visceral surgery, was recently adopted in head and neck surgical oncology, but has not found widespread adoption, so far. [12] This classification allows a comprehensive recording of all even minor complications, including a grading scale related to the severity of complication with an easy-to-use scoring system. It allows a simple and objective comparison of the complications between different types of surgical interventions, for the same procedure over time

and by surgeon within the same institution and between different institutions respectively. The different grades of Clavien-Dindo complications are defined according to the consequences on a therapeutic level, and long-term morbidity and mortality.

The goal of our study was to analyze complications occurring during the perioperative period. Indeed, little is known about the true prevalence and severity of acute complications occurring during the first days following parotidectomy when long-term complications (6-24 months postoperatively) and sequelae have been extensively studied in the literature [14-16]. However, providing data about the prevalence and severity of short-term complications following parotidectomy is paramount to inform the patients properly about the risks related to surgery. Perioperative complications may have an impact on the duration of hospital stay and related costs and, last but not least, their recognition may lead to modifications and improvements in the surgical management. We selected the Clavien-Dindo classification because it seemed to us as the most suitable for identifying and assessing short-term postoperative complications. The high rate of reported complications can be explained by using a standardized grading scheme where even the most minor complications were recorded whereas they are not usually reported with other systems. Indeed, our findings are consistent with prior reports, albeit in other surgical subspecialties, comparing administrative datasets to chart review. [17,18] Heisler et al showed that claims data accurately identifies life-threatening complications after vaginal hysterectomy when other complications are underreported. [17] This is consistent with a study addressing complications after oral cancer surgery. The authors demonstrated that 98% of all major complications were reported but many minor complications failed to report.[12] In our study, 98.2% of the complications were minor (grades I and II), while only 1.8% were considered as major (grade III).

We report a high rate of 61.7% of acute postoperative facial paralysis. In the literature, the rate of facial paralysis reported in the immediate postoperative period is extremely variable, ranging from 9.3 to 68%. [19–28] This large variability can be explained by the lack of consensus regarding the timing of facial function assessment. Indeed, even when a discrete weakness is frequently observed during the first postoperative days, spontaneous improvement occurs a few weeks later. Most of those patients are generally rated House-Brackmann grade I (normal facial function) when they are assessed a few months after surgery.[29, 30] Therefore, facial function evaluation performed during the first postoperative days will be more severe on the rate of immediate paralysis. In our series, a complete facial nerve recovery at 3, 6 and 12 months was observed in 86.9%, 93.7% and 98.1% respectively. These results are in line with those reported in the literature. [23,26,27, 29,30] In our study, partial superficial parotidectomy is associated with a lower risk of postoperative facial paralysis. In the literature, the extent of surgical resection in the parotid gland is a well-identified factor increasing the risk of postoperative facial paralysis. [19,23,24, 27,29,31]

In our series, a longer duration of surgery is associated with a higher risk of postoperative complications, as it has been reported by others.[19]

We are not able to demonstrate that facial nerve monitoring use of is associated with a reduction of perioperative facial paralysis. This result may be biased because during the major part of the study period, intraoperative facial nerve monitoring was mostly used in cases where difficulty to identifying the facial nerve was anticipated. Currently, routine use of neuromonitoring in parotid gland surgery decreases the duration of the intervention and, accordingly, the risk of complications

should be reduced. This observation should be objectively documented when an adequate number of parotidectomies under neuromonitoring will be achieved.

Other factors with a significant impact on the rate of 30-day postoperative complications were identified. An increase in BMI slightly increased the risk of healing disorders. In the whole series, the rate of seromas (and sialoceles) is higher (19.8%) than reported by others including sialoceles alone in partial superficial parotidectomy exclusively.[32] We show that use of active suction drainage increases the risk of developing a seroma. A recent Danish study reported that the risk of seroma and hematoma after superficial parotidectomy increased with secretion beyond 25 ml/24 hours, questioning the use of routine drainage after superficial parotidectomy.[33]

The median hospital stay is shorter in patients without complication than in patients with perioperative complications than in patients with complications. A recent study reported that partial superficial parotidectomy was associated with a shorter hospital stay and fewer complications especially transient facial paralysis than superficial parotidectomy.[31] Longer hospital stay is also observed in patients who had perioperative complications using non parametric analysis. Of note, patients who developed a seroma had a statistically significantly shorter hospital stay than those who did not. The occurrence of seroma could be related to a premature ablation of the drainage of the surgical site.

In our study, ASA score > 1 is not associated with a higher risk of complications, suggesting that preexisting patient comorbidities has no influence on acute postoperative complication rates. The specific correlation of ASA scores with operating times, hospital length of stay, postoperative infection rates, overall morbidity and mortality rates following gastrointestinal, cardiac, and genitourinary surgery has been extensively studied.[34-38] We were not able to show any correlation between ASA score and complications rates. Of note, 90% of our patients were scored ASA 1 and ASA 2. It is however important in similar studies to take in consideration the comorbidities to avoid biased comparison between institutions. Outcome measures need to be risk-adjusted before they are benchmarked.

Limitations to this study are first related to the retrospective nature of our analysis leading to variability in reporting complication practices meaning that many definitions were open to interpretation. This was minimized by looking at all data sources available, including recorded reports from the senior surgeons who performed all procedures, laboratory values and radiological findings. Next, a study of this magnitude is particularly laborious and time-consuming and was only possible thanks to reliance upon institutional electronic medical records. Last, although we have focused primarily on early postoperative complications, long term patient-centered clinical (and oncologic) outcomes need to be measured to assess quality of care following parotidectomy.[39]

5. Conclusions

Use of a standardized, scaled classification of postoperative complications shows that parotid gland surgery are surgical procedures followed by a rate of 30-day postoperative complications higher than that usually reported. Longer hospital stay is observed in patients with perioperative complications. These informations must be mitigated because almost all of these complications are minor with a limited consequence on the duration of the hospital stay and with no long-term sequelae. It is

important to inform objectively the patients about the potential short-term complications related with this surgical procedure, when emphasizing the favorable long-term prognosis.

Supplementary Materials: The following are available online at www.mdpi.com/xxx/s1, Table S1: Univariate logistic regression with selected variables for wound healing complications, Table S2: Multivariate logistic regression for wound healing perioperative complications after parotidectomy, Table S3: Univariate logistic regression with selected variables for perioperative occurrence of seroma, Table S4: Multivariate logistic regression for occurrence of seromas, Table S5: Univariate logistic regression with selected variables for Clavien-Dindo grade > 1 complications, Table S6: Multivariate logistic regression for Clavien-Dindo grade > 1 complications. Figure S1: Length of hospital stay with no facial paralysis, Figure S2: Length of hospital stay with facial paralysis, Figure S3: Length of hospital stay with no wound healing complication, Figure S4: Length of stay in patients with wound healing complications, Figure S5: Length of hospital stay with no seroma/sialocele, Figure S6: Length of hospital stay with seroma/sialocele.

Author Contributions: Conceptualization, MH SS; methodology, MH, SS; validation, AVM; formal analysis, NT; investigation, NT; data curation, AVM.; writing—original draft preparation, NT; writing—review and editing, MH, SS. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Conflicts of Interest: The authors declare no conflict of interest.

References

- [1] Shah JP, Patel SG, Singh B. Salivary Glands, in Shah JP, editor. Head and Neck Surgery and Oncology, 4th Edition, Philadelphia, Elsevier Mosby, 2012, pp. 526–69.
- [2] Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004;240(2):205-213. doi: 10.1097/01
- [3] Dripps RD, Lamont A, Eckenhoﬀ JE. The Role of Anesthesia in Surgical Mortality. *JAMA.* 1961;178:261-266. doi: 10.1001
- [4] Kim BD, Lim S, Wood J, Samant S, Ver Halen JP, Kim JY. Predictors of adverse events after parotidectomy: a review of 2919 cases. *Ann Otol Rhinol Laryngol.* 2015;124:35-44. doi: 10.1177/0003489414542089
- [5] Gierth M, Zeman F, Denzinger S, Vetterlein MW, Fisch M, Bastian PJ, Syring I, Ellinger J, Müller SC, Herrmann E, et al. Influence of Body Mass Index on Clinical Outcome Parameters, Complication Rate and Survival after Radical Cystectomy: Evidence from a Prospective European Multicentre Study. *Urol Int.* 2018;101:16-24. doi:10.1159/000488466..
- [6] Bono OJ, Poorman GW, Foster N, Jalai CM, Horn SR, Oren J, Soroceanu A, Ramachandran S, Purvis TE, Jain D, Vira S, Diebo BG, Line B, Sciubba DM, Protosaltis TS, Buckland AJ, Errico TJ, Lafage V, Bess S, Passias PG. Body mass index predicts risk of complications in lumbar spine surgery based on surgical invasiveness. *Spine J.* 2018;18:1204-1210. doi: 10.1016/j.spinee.2017.11.015.
- [7] Sems SA, Johnson M, Cole PA, Byrd CT, Templeman DC; Minnesota Orthopaedic Trauma Group. Elevated body mass index increases early complications of surgical treatment of pelvic ring injuries. *J Orthop Trauma.* 2010 May;24(5):309-14. doi: 10.1097.
- [8] Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, de Santibañes E, Pekolj J, Slankamenac K, Bassi C, Graf R, Vonlanthen R, Padbury R, Cameron JL, Makuuchi M. The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg.* 2009;250:187-196. doi: 10.1097/SLA.0b013e3181b13ca2.
- [9] House JW, Brackmann DE. Facial nerve grading system. *Otolaryngol Head Neck Surg.* 1985;93:146-147. doi: 10.1177/019459988509300202.
- [10] Agresti A. Categorical Data Analysis, 2nd Edition. New-York, John Wiley & Sons, 2002.
- [11] Jalisi S, Bearely S, Abdillahi A, Truong MT. *Outcomes* in head and neck oncologic surgery at academic medical centers in the United States. *Laryngoscope* 2013 Mar;123(3):689-98. doi: 10.1002/lary.23835.
- [12] Awad MI, Shuman AG, Montero PH, Palmer FL, Shah JP, Patel SG. Accuracy of administrative and clinical registry data in reporting postoperative complications after surgery for oral cavity squamous cell carcinoma. *Head Neck.* 2015;37:851-861. doi: 10.1002/hed.23682.
- [13] Veen EJ, Janssen-Heijnen ML, Leenen LP, Roukema JA. The registration of complications in surgery: a learning curve. *World J Surg.* 2005 ;29:402-409. doi: 10.1007/s00268-004-7358-8.
- [14] Wolber P, Volk GF, Horstmann L, Finkensieper M, Shabli S, Wittekindt C, Klussmann JP, Guntinas-Lichius O, Beutner D, Grosheva M. Patient's perspective on long-term complications after superficial parotidectomy for benign lesions: Prospective analysis of a 2-year follow-up. *Clin Otolaryngol.* 2018 Mar 26. doi: 10.1111/coa.13104. Online ahead of print.
- [15] Kaya BV, Kılıç C, Özlügedik S, Tuncel Ü, Cömert E. Long-term effects of parotidectomy. *Eur Arch Otorhinolaryngol.* 2016;273:4579-4583. doi: 10.1007/s00405-016-4173-4.

- [16] Fang QG, Shi S, Zhang X, Li M, Liu FY, Sun CF. Long term quality of life in pediatric patients surviving parotid tumors. *Int J Pediatr Otorhinolaryngol*. 2014;78:235-237. doi: 10.1016/j.ijporl.2013.11.011
- [17] Heisler CA, Melton LJ 3rd, Weaver AL, Gebhart JB. Determining perioperative complications associated with vaginal hysterectomy: code classification versus chart review. *J Am Coll Surg*. 2009;209(1):119-122. doi: 10.1016/j.jamcollsurg.2009.03.017.
- [18] Romano PS, Chan BK, Schembri ME, Rainwater JA. Can administrative data be used to compare postoperative complication rates across hospitals? *Med Care*. 2002;40:856-867. doi: 10.1097/00005650-200210000-00004.
- [19] Dulguerov P, Marchal F, Lehmann W. Postparotidectomy facial nerve paralysis: possible etiologic factors and results with routine facial nerve monitoring. *Laryngoscope*. 1999; 109: 754-762. doi: 10.1097/00005537-199905000-00014.
- [20] Bova R, Saylor A, Coman WB. Parotidectomy: review of treatment and outcomes. *ANZ J Surg*. 2004;74:563-568. doi: 10.1111/j.1445-2197.2004.02988.
- [21] Bron LP, O'Brien CJ. Facial nerve function after parotidectomy. *Arch Otolaryngol Head Neck Surg*. 1997;123:1091-1096. doi: 10.1001/archotol.1997.01900100065009.
- [22] Stodulski D, Skorek A, Mikaszewski B, Wiśniewski P, Stankiewicz C. Facial nerve grading after parotidectomy. *Eur Arch Otorhinolaryngol*. 2015;272:2445-2450. doi: 10.1007/s00405-014-3196-y.
- [23] Koch M, Zenk J, Iro H. Long-term results of morbidity after parotid gland surgery in benign disease. *Laryngoscope*. 2010 ;120:724-730. doi: 10.1002/lary.20822.
- [24] Roh JL, Park CI. A prospective, randomized trial for use of prednisolone in patients with facial nerve paralysis after parotidectomy. *Am J Surg*. 2008;196:746-750. doi:10.1016/j.amjsurg.
- [25] Gaillard C, Périé S, Susini B, St Guily JL. Facial nerve dysfunction after parotidectomy: the role of local factors. *Laryngoscope*. 2005 Feb;115(2):287-91. doi: 10.1097/01.mlg.0000154735.61775.cd
- [26] Mehle ME, Kraus DH, Wood BG, Benninger MS, Eliachar I, Levine HL, Tucker HM, Lavertu P. Facial nerve morbidity following parotid surgery for benign disease: the Cleveland Clinic Foundation experience. *Laryngoscope*. 1993;103:386-388. doi: 10.1002/ lary.5541030404.
- [27] Guntinas-Lichius O, Klussmann JP, Wittekindt C, Stennert E. Parotidectomy for benign parotid disease at a university teaching hospital: outcome of 963 operations. *Laryngoscope*. 2006;116: 534-540. doi: 10.1097/01.mlg.0000200741.37460.ea.
- [28] Marchese-Ragona R, De Filippis C, Marioni G, Staffieri A. Treatment of complications of parotid gland surgery. *Acta Otorhinolaryngol Ital*. 2005;25:174-178.
- [29] Upton DC, McNamar JP, Connor NP, Harari PM, Hartig GK. Parotidectomy: ten-year review of 237 cases at a single institution. *Otolaryngol Head Neck Surg*. 2007;136:788-792. doi: 10.1016/j.otohns.2006.11.037.
- [30] Bittar RF, Ferraro HP, Ribas MH, Lehn CN. Facial paralysis after superficial parotidectomy: analysis of possible predictors of this complication. *Braz J Otorhinolaryngol*. 2016;82:447-451. doi: 10.1016/j.bjorl.2015.08.024.
- [31] Mlees MA, Elbarbary AH. Superficial or partial superficial parotidectomy for the treatment of primary benign parotid tumors. *J Surg Oncol*. 2020 Oct 11. doi: 10.1002/jso.25970.

- [32] Lee YC, Park GC, Lee JW, Eun YG, Kim SW. Prevalence and risk factors of sialoceles formation after partial superficial parotidectomy: A multi-institutional analysis of 357 consecutive patients. *Head Neck*. 2016;38 Suppl 1:E941-944. doi: 10.1002/hed.24130.
- [33] Nielsen CF, Riis CBS, Christensen ALB, Mirz F, Reinholdt KB, Ovesen T, Fjaeldstad AW. Superficial Parotidectomy: Impact of Postoperative Drainage. *Ear Nose Throat J*. 2020 Aug 3;145561320942380. doi: 10.1177/0145561320942380.
- [34] Ridgeway S, Wilson J, Charlet A, Kafatos G, Pearson A, Coello R. Infection of the surgical site after arthroplasty of the hip. *J Bone Joint Surg Br*. 2005;87:844-850.
- [35] Tang R, Chen HH, Wang YL, Changchien CR, Chen JS, Hsu KC, Chiang JM, Wang JY. Risk factors for surgical site infection after elective resection of the colon and rectum: a single-center prospective study of 2,809 consecutive patients. *Ann Surg*. 2001;234:181-189. doi: 10.1097/00000658-200108000-00007.
- [36] Sauvanet A, Mariette C, Thomas P, Lozac'h P, Segol P, Tiret E, Delperro JR, Collet D, Leborgne J, Pradère B, et al. Mortality and morbidity after resection for adenocarcinoma of the gastroesophageal junction: predictive factors. *J Am Coll Surg*. 2005;201:253-262. doi: 10.1016/j.jamcollsurg.2005.02.002.
- [37] Prause G, Offner A, Ratzenhofer-Komenda B, Vicenzi M, Smolle J, Smolle-Jüttner F. Comparison of two preoperative indices to predict perioperative mortality in non-cardiac thoracic surgery. *Eur J Cardiothorac Surg*. 1997;11:670-675. doi: 10.1016/s1010-7940(97)01150-0.
- [38] Carey MS, Victory R, Stitt L, Tsang N. Factors that influence length of stay for in-patient gynaecology surgery: is the Case Mix Group (CMG) or type of procedure more important? *J Obstet Gynaecol Can*. 2006;28(2):149-155. doi: 10.1016/s1701-2163(16)32057-6.
- [39] Porter ME. What is value in health care? *N Engl J Med*. 2010;363: 2477-2481. doi: 10.1056/NEJMp1011024.