

Review of surgical techniques and guide for decision making in the treatment of benign parotid tumors

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Abstract

Purpose Surgical treatment of benign parotid tumors has developed in the direction of less invasive procedures in recent years and has raised great debate about the best surgical approach. Aim of this article is to analyse anatomical and other factors that are important in selection of the appropriate surgical technique in treatment of benign parotid tumors. Furthermore, to discuss the risk of complications and recurrent disease according to selected operation. Finally, to define patient selection criteria to facilitate decision making in parotid surgery and become a guide for younger surgeons.

Methods Literature review and authors' personal opinions based on their surgical experience.

Results All possible surgical techniques for benign parotid surgery with advantages and disadvantages are being described. An algorithm with anatomical and other criteria influencing decision making in benign parotid surgery is presented.

Conclusion Surgeons nowadays have many options to choose from for benign parotid surgery. ECD is one of the many surgical techniques available in parotid surgery and can achieve excellent results with proper training and if used for proper indications. PSP is mainly indicated in large tumors of the caudal part of the PG (ESGS level II). SP represents a universal solution in parotid surgery and should be the first technique young surgeons learn. TP has only few but important indications in benign parotid surgery. Surgeons need to carefully consider the patient and his/her preoperative imaging as well as her or his own special expertise to select the most appropriate surgical technique.

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Abbreviations

ECD	Extracapsular dissection
PSP	Partial superficial parotidectomy
SP	Superficial parotidectomy
TP	Total parotidectomy
FN	Facial nerve
PG	Parotid gland
MSCM	Sternocleidomastoid muscle
IONM	Intraoperative neuromonitoring
PLA	Pleomorphic adenoma
SD	Stensen's duct
MRI	Magnetic resonance imaging
RMV	Retromandibular vein
ESGS	European Salivary Gland Society [now: Multidisciplinary Salivary Gland Society (MSGGS)]

Introduction

Parotid gland surgery has experienced a great evolution in the last 20 years. Although superficial parotidectomy (SP) was standard of care in many centres until some years ago, other operative options, such as extracapsular dissection (ECD) and partial superficial parotidectomy (PSP) have become popular [1–3]. Both surgical techniques have advantages and disadvantages, but a direct comparison is very difficult. Overall, the surgical treatment of benign parotid tumors has developed in the direction of less invasive procedures in the recent years [4]. In some centres nowadays, the most frequently performed operation is the ECD in which the facial nerve (FN) is not routinely identified [5, 6].

The various operative possibilities have a great impact on the surgical time needed (40 min to 4 h), on the incidence of FN paralysis both temporary (10–40%) and permanent (1–5%), on the probability of postoperative Frey's syndrome and loss of sensation (injury of the great auricular nerve) [7–12]. Even the risk of a postoperative salivary fistula and thus the duration of wound healing vary greatly depending on the extent of the surgical technique [13–15].

Surgery of benign parotid neoplasms has a clear scope: a complete removal of the tumor with minimal morbidity. Complete tumor removal with clear resection margins is very important to minimize the chances for local recurrence especially for pleomorphic adenomas (PLA) [16, 17]. Furthermore, since preoperative exclusion of malignancy is not always possible, the histologic clarification of the tumor is another important aspect of surgery, because unexpected malignancy could make revision surgery mandatory. Minor goals are preservation of salivary function and having a favorable situation if revision surgery becomes necessary (e.g. recurrence of pleomorphic adenoma, metachronous Warthin's tumor, incidental malignancy) [18, 19]. Although there is little debate about the aim of surgery in

benign parotid tumors, there is still great debate about the appropriate surgical approach. Mainly two doctrines dominate the modern opinion. The first emerged around 1950 and supports the notion that the minimum surgical procedure in parotid surgery is superficial or lateral parotidectomy [16, 20, 21]. The second that slowly emerged 25 years ago supports that ECD is a viable option in selected cases of benign parotid surgery [1, 22–24]. Nevertheless, a systematic comparison between ECD and SP is difficult because selection bias hinders a direct comparison [25, 26]. To facilitate comparison in future studies, a new classification of tumors according to their size and location within the parotid gland has been proposed by the European Salivary Gland Society (ESGS), nowadays renamed as Multidisciplinary Salivary Gland Society (MSGGS) [26, 27].

The purpose of this review paper is to analyze the factors that are important in the selection of the appropriate surgical technique in the treatment of benign parotid tumors. Furthermore, it discusses the risk of FN palsy and recurrent disease according to the selected operation. Finally, it defines selection criteria in order to facilitate decision making in parotid surgery and become a guide for younger surgeons. In order to understand the treatment possibilities in benign parotid tumors, it is necessary to analyze the surgical techniques that are available and their historical development.

Surgical techniques available and historical development

Table 1 shows the techniques that are available for surgical treatment of benign or malignant parotid disease. Fine needle aspiration (FNA), core needle biopsy (CNB) and open biopsy are diagnostic procedures that will not be further discussed in this paper. Nevertheless it is generally accepted that although having their indications, they cannot offer 100% diagnostic accuracy [28–32].

Enucleation is nowadays obsolete, but had a great impact on the development of parotid surgery [16]. This technique, which is also called intracapsular dissection, entails the incision of the capsule of the tumor and the removal of the content within the borders of the tumor. This method was developed in the early 20th century in a time when neither neuromonitoring, nor bipolar coagulation or visual magnification were available and the fear of injuring the FN was the main concern of the surgeons. As it is easy to imagine, since the tumor removal was performed within the capsule of the tumor, small rests of the tumor were usually left behind and the recurrence rate, especially for pleomorphic adenomas (PLA) was very high at 30–50% [16, 33]. Because of that the superficial or lateral parotidectomy was developed to combine complete tumor removal and FN safety. In a time when neuromonitoring was still not available, the

Table 1 Surgical techniques available in parotid surgery

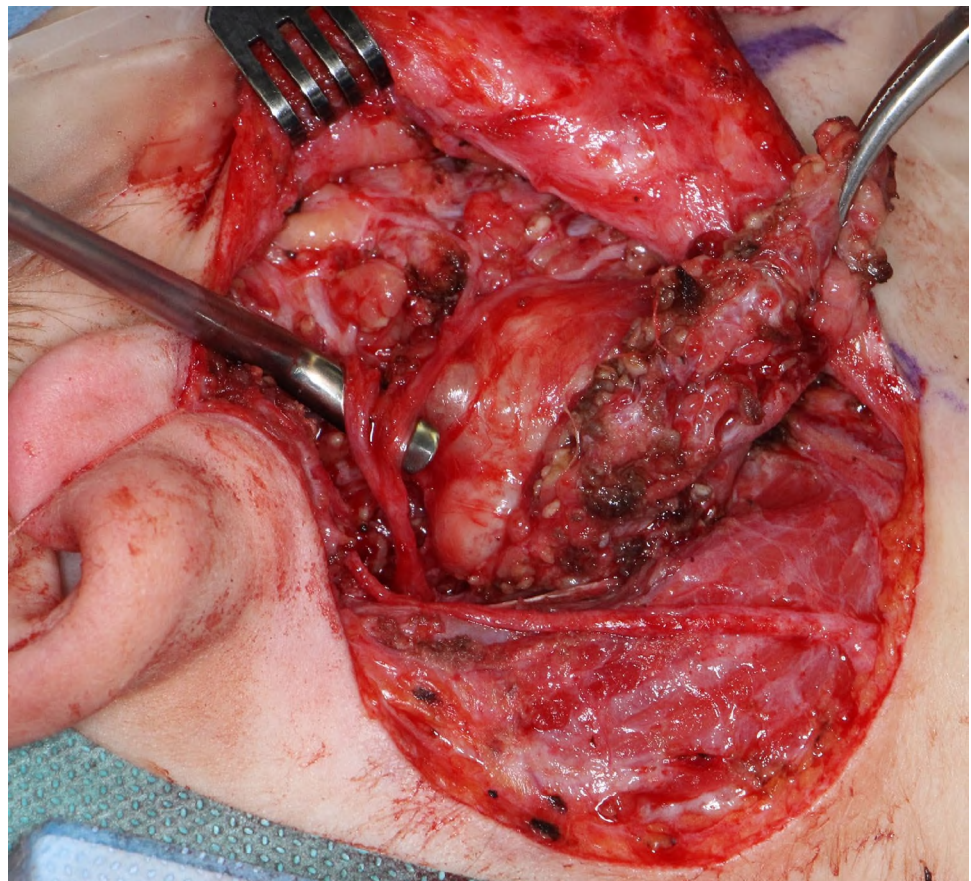
Surgical technique
Biopsy (FNA, CNB, open biopsy)
Enucleation (intracapsular dissection) (obsolete)
Capsular dissection (extracapsular enucleation) (without removal of healthy parotid tissue)
Extracapsular dissection (partial parotidectomy)
Partial parotidectomy with main trunk preparation (partial superficial parotidectomy-PSP)
Superficial (lateral) parotidectomy
Total/near-total parotidectomy
Radical parotidectomy (nerve resection)
Extended parotidectomy (e.g. masseter, MSCM, external ear, lateral petrosectomy)

FNA fine needle aspiration, *CNB* core needle biopsy, *MSCM* sternocleidomastoid muscle

identification of the main trunk of the FN, in an anatomically safe region, directly after exiting the stylomastoid foramen, and the exploration of the nerve branches from central to the periphery gave the best combination of complete tumor removal and FN safety. Because of the impressive decrease in recurrences, SP was established as the standard of treatment in parotid surgery especially if a PLA was suspected. Histologic examination of microsattellites strengthened the believe that wide surgical margins are necessary in order to minimise recurrence of PLA [34].

Capsular dissection or extracapsular enucleation represents the excision of the tumor in a plane directly in contact to the external surface of the tumor capsule without the removal of healthy parenchymal tissue [16]. Although capsular dissection is not a technique aimed at during surgery, a partial capsular dissection of a tumor often becomes necessary during more extended surgery such as SP or total parotidectomy (TP) because the tumor is often in contact with the main trunk or branches of the FN (Figs. 1, 10). Donovan already showed in 1984 that as much as 60% of SP

Fig. 1 Capsular dissection in patient with pleomorphic adenoma of the deep lobe of the right PG undergoing TP verify correct functioning of the IONM



or TP unavoidably had a capsular dissection phase at some point of the surgical procedure—because of the tumor abutting on the FN—without worsening recurrence rates [35]. That way he proved that low recurrence rates are possible even without wide surgical margins during operation. Since many parotid tumors have contact with the FN, and since besides the removal of the tumor, the goal is to preserve FN function, the dissection must be made in very close proximity to the tumor capsule in order to prevent FN injury. If a substantial margin would be essential to prevent recurrence, one would expect these patients to have increased recurrence rates. On the contrary, however, very low recurrence rates are observed in these patients with partial capsular exposure, on the condition that the capsule of PLA is not injured during surgery [16]. Therefore, it can be assumed that properly indicated and performed ECD has no reason to have higher recurrence rates as compared to SP or TP.

Extracapsular dissection (ECD) may also be termed partial parotidectomy without main trunk preparation, as after skin flap preparation, the parotid tissue is opened near the lesion and the tumor—surrounded by some millimeters of healthy tissue—is removed. The main difference to SP is that the main trunk of the FN is not dissected. Nevertheless, at some point of the operation one or more branches of the FN are usually identified. It is rare not to identify or stimulate any branch during surgery. In cases that a nerve branch is in contact with the tumor a partially capsular dissection becomes necessary. The development of intraoperative neuromonitoring (IONM) in the 1990s improved safety of FN during ECD [36–38]. Based on this technique, it became possible to control the region around the tumor and identify and protect branches of the FN without exactly knowing where they are going to be met. Therefore, during ECD the IONM has another function and importance compared to SP. In SP or TP, the main trunk of the FN is identified and IONM verifies that the region of interest (ROI) is the nerve (positive verification) [36]. Therefore, the stimulation level of 0.8–1 mA is usually enough. During ECD, most of the operation is performed without visual exposure of a branch of the FN. The importance of IONM in this case is to verify that the ROI is not a nerve but tissue that can be cut (negative verification). Therefore, much higher stimulation levels are needed (usually 3–5 mA) in order to minimise the danger of false negative results (i.e. IONM does not give a stimulation signal although in contact to or very close to the FN). Because false negative results in IONM would greatly increase the danger to damage the FN, a correct application of IONM is essential in ECD. Furthermore, it is highly important to verify the correct function of the IONM system during surgery. In case of SP this can easily be done by regularly stimulating the dissected main trunk of the FN. After preparing the skin flap in ECD, a good way to start identifying the FN using IONM is usually the mandibular branch, as it is almost always possible to stimulate it with 5 mA at the angle of the mandible. In this way, it

becomes apparent that the correct use of IONM is an essential part of a safe performance of an ECD [39]. Further developments that promoted the use of ECD were bipolar coagulation and visual magnification because they facilitated the identification and protection of small branches of the FN [40–42]. Many studies have examined the ECD for efficacy and safety in the last 15–20 years [6, 22, 23, 43–45] and compared it to other forms of parotidectomy [46–48].

Partial superficial parotidectomy (PSP) was developed as a less invasive alternative to SP in selected cases, aiming to improve complication rates without worsening recurrence rates [2, 27, 49–52]. Most of the studies verify the effectiveness of this technique, the relative preservation of glandular function and the improved complication profile [3, 53–56]. However, the extent of PSP is not well defined. Many publications use different definitions that make an evaluation of this technique difficult [57]. Our suggestion is to use the definition proposed by the European Salivary Gland Society (ESGS) which divides the parotid gland in five levels. PSP is defined as dissection of the main trunk of the FN and one of the two major divisions (temporofacialis, cervicofacialis) and removal at least of one level of the parotid gland [27]. In some departments also the term “partial parotidectomy with main trunk preparation” is used because it gives a clear distinction between PSP and ECD which is a partial parotidectomy without main trunk preparation.

Superficial or lateral parotidectomy (SP) and subtotal/total parotidectomy (TP) still play an important role in benign parotid surgery independently of the opinion or approach one represents [20, 22, 58]. The first step after skin flap preparation is to identify the main trunk of the FN, follow all branches and remove the superficial part of the parotid gland (ESGS levels I and II) with the tumor. Since the main trunk of the FN is identified at the beginning of the procedure it makes it suitable for large tumors and tumors with broad contact to the central parts of the FN, as well as tumors located underneath the FN branches. Main advantages of the method are the standardized identification of the FN which makes its protection independent of tumor size and location and correct function of the neuromonitoring, and thus being very well teachable in a standardized way to junior surgeons [59]. In a minority of patients, where the tumor has a substantial volume around the stylomastoid foramen, especially anterior and inferior, a retrograde preparation of the FN is necessary in order not to injure the tumor capsule [60, 61].

Indications for different surgical techniques in benign parotid surgery

It is important to note that surgical techniques are under continuous evolution and development. The indications presented in this study represent the opinion of surgeons that

perform a high number of parotid gland surgery every year and have great experience with all kinds of presented procedures. Novice surgeons should start their career by learning how to identify the main trunk of the FN first and perform PSP or SP in patients with a superficially located tumor, and then, once they have a sufficiently large patient population and a substantial experience in selecting the right patient, proceed to less invasive techniques like ECD. A parallel training in both techniques should only be preserved in high volume centres under the intense supervision of experienced surgeons who could take over the procedure and perform a more extended parotidectomy if needed. Performing ECD because of surgical technical insufficiency, i.e. not being able to identify the FN, has to be avoided, because it will lead to false indications and an increase of complications and recurrences [47].

(Anatomical) Criteria that influence decision making in benign parotid surgery are tumor size, tumor location (in caudal or cranial part of the parotid gland), mobility of the tumor, distance from the surface of the parotid gland, proximity to the retromandibular vein (RMV), the FN and the Stensen's duct (ESGS level V). Especially the proximity of the tumor to the RMV can be detected with ultrasound or MRI and has been proven to be a great indicator of proximity to the FN [62, 63]. Therefore, it is very important for the surgeon to thoroughly examine the available imaging of the patient and choose the proper surgical procedure before entering the operating theatre [64]. On the other hand, surgeons need to be flexible and able to intraoperatively switch in a more extended surgical technique if unexpected findings occur.

Indications for extracapsular dissection (ECD)

Since ECD is a limited procedure which is performed around the lesion, the extent of surgery highly depends on size and localization of the tumor and is therefore individualized for every patient. Therefore, indications for ECD may be divided into "ideal" and "possible". "Ideal" indications are lesions that can safely be removed with ECD, so they can be recommended to surgeons that start doing ECD, because they do not need large experience in this kind of surgery to be able to perform it safely (Fig. 2). "Possible" indications represent tumors that are much riskier if performed by inexperienced surgeons (Fig. 5).

"Ideal" indications are typically, small tumors (≤ 2 cm) in the periphery of the parotid gland (Fig. 2). Especially well palpable and mobile tumors of the caudal part of the parotid gland with no contact to the cervicofacial division of the FN are the best candidates for ECD. In these cases, even tumors larger than 2 cm might represent "ideal" candidates. An important landmark to this region of the gland is the RMV. Because the marginal mandibular branch of the

FN is commonly located cranial to this landmark (Fig. 8) [62]. Warthin tumors are frequently localized in this region and fulfil these criteria [65, 66]. A limited semicircular incision caudal the ear lobule is usually enough, omitting the usual preauricular extension of the Blair incision (Fig. 3). After skin-flap preparation, the parotid tissue can be opened a few millimeters away from the tumor and the latter can be removed with a sheet of healthy tissue surrounding it. However, as Donovan and Conley observed for SP, careful capsular dissection is unavoidable also in ECD if the tumor abuts the nerve [35]. Since these tumors are near or in contact with the sternocleidomastoid muscle (MSCM), it is important to dissect the muscle carefully in order not to injure the capsule of the tumor. A preparation down to the posterior belly of the digastric muscle (MDVP) can usually help to mobilize the tumor and facilitate resection. Small tumors of the tail (caudal-anterior part) of the parotid gland are also very good candidates for ECD. Since the tumor is near the angle of the mandible in these cases, however, the possibility to meet the marginal mandibular branch of the FN is markedly higher (Fig. 4). Small tumors of the peripheral cranial part of the parotid gland are less frequent and usually in close contact to the temporal branch of the FN (Fig. 2). Yet, if they are located at a distance to the temporofacial branch of the FN, ECD may be safe to perform. In tumors that fulfil the above criteria ECD has a lot of benefits compared to SP and according to surgeons performing ECD even to PSP. The incidence of temporary FN palsy and Frey's syndrome is lower, surgical time is shorter and function of the parotid gland (GP) is not impaired [5, 18, 22, 44, 46, 67]. Furthermore, possible revision surgeries (e.g. because of recurrence or incidental malignancy), do not have an increased danger to injure the FN unlike in PSP or SP [19]. In centres with a high grade of experience, ECD can be applied in more than half of the procedures for benign parotid tumors [23].

For experienced surgeons, indications for ECD can be further expanded (Fig. 5). "Possible" indications are large tumors (2–4 cm) of the caudal part of the GP with some contact to the cervicofacial branch of the FN (ESGS level II), mid-sized tumors of the cranial superficial part of the GP with contact to the temporal branch of the FN (ESGS level I) and small tumors at the anterior superficial part of the GP near the Stensen duct (ESGS level V) [27]. In such cases, the benefits of ECD successively diminish. The extent of the incision will not be different from the one used in PSP. With increasing size of the tumor and proximity to the FN, the difficulty of the dissection and the danger for the FN increases. Furthermore, surgical time can even surpass that of a PSP. If during ECD the tumor proves to be larger than initially estimated and the main trunk of the FN eventually must be retrograde exposed because of the proximity of the tumor to the FN, PSP or SP would have been the best choice in the first place. The initial decision can be facilitated by

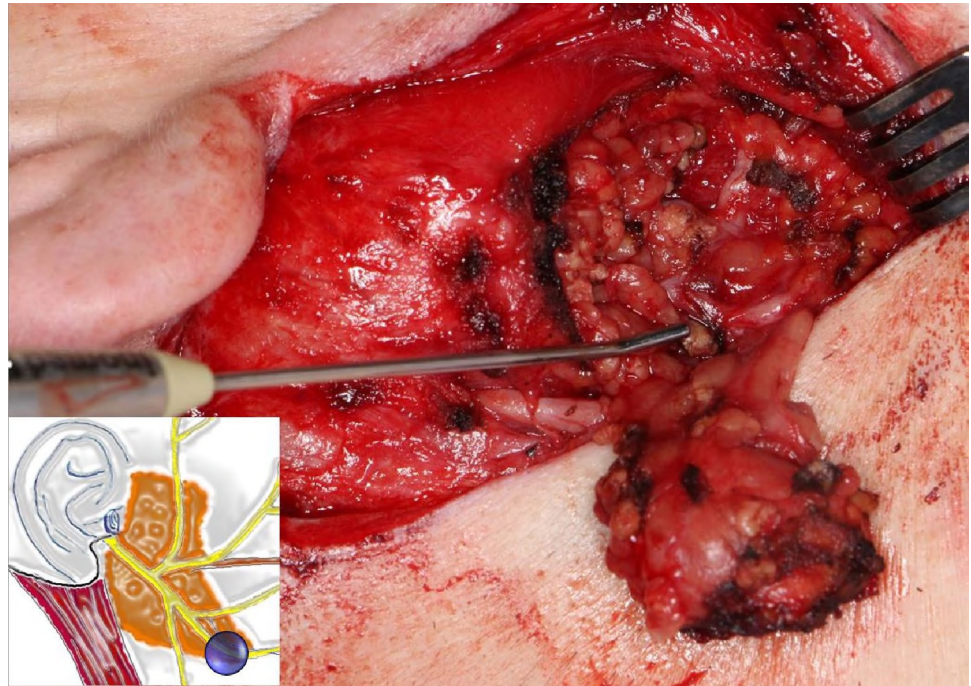
Fig. 2 Location and size of benign parotid tumors that represent “ideal” candidates for ECD



Fig. 3 Limited semi-circular incision caudal of the ear lobule, for ECD or PSP of the caudal part of the right PG



Fig. 4 Identification of the mandibular branch of the FN during ECD at the tail of the right PG



careful examination of preoperative imaging and measuring the distance of the tumor from the parotid surface and the proximity of the RMV to the tumor which are strong indicators with regards to the proximity of the tumor to the FN [62].

Benign tumors of the anterior part of the parotid gland near Stensen's duct (ESGS level V) represent a very special situation [68]. In these cases, ECD is very challenging because Stensen's duct has to be identified and preserved. On the other hand, preservation of parotid function and improved aesthetic outcomes are significant benefits compared to SP (Fig. 6).

Indications for partial superficial parotidectomy (PSP)

Main indication for PSP are middle-sized (3–4 cm) tumors in caudal part of GP (ESGS level II) with contact to the main trunk of the FN and large tumors (> 4 cm) of the caudal part of the GP (ESGS level II) with contact to the main trunk and the cervicofacial branch of the FN (Fig. 7). In these cases, limited incision (Fig. 3), dissection of the cervicofacial division of the FN and removal of the caudal part of the parotid gland are sufficient. The temporofacial division and the cranial part of the parotid gland (ESGS level I) can be left untouched (Fig. 8). Especially inexperienced surgeons should consider performing PSP in all cases of tumors of the caudal part of the parotid gland to gain experience with dissecting the main trunk of the FN. As well, surgeons with limited caseload (e.g. < 20 parotidectomies per year) would

probably be well advised to always perform PSP or SP. On occasion, PSP can be indicated for tumors near the temporofacial division of the FN within the cranial part of the parotid gland (ESGS level I) (Fig. 7). However, it should be noted, that tumors of the cranial part of the parotid gland, frequently need SP to be successfully removed, but if suitable can be dissected with ECD by the experienced surgeon.

Indications for superficial parotidectomy (SP)

SP can be performed for dissection of every benign tumor of the superficial part of the parotid gland (ESGS levels I and II, but also when the tumor is in level III) and is still considered by some surgeons as the gold standard in parotid surgery [20, 21]. In centers that use ECD and PSP, SP is usually preserved for medium sized tumors with contact to both the cervicofacial and the temporofacial division of the FN, which sometimes becomes apparent only during surgery. Further indications are large tumors of the cranial part of the GP (ESGS level I) with contact to the temporal branch and extension up to the main trunk of the FN and large tumors with contact to multiple branches of the FN, but without extension to the deep lobe of the GP.

Subtotal/total parotidectomy (TP)

Usually, the indication for TP is in the treatment of malignant tumors. In benign surgery, TP is usually preserved for tumors of the deep lobe of the GP with contact to the FN (ESGS level IV), dumbbell tumors located underneath the

Fig. 5 Location and size of benign parotid tumors that represent “possible” indications for ECD for experienced surgeons

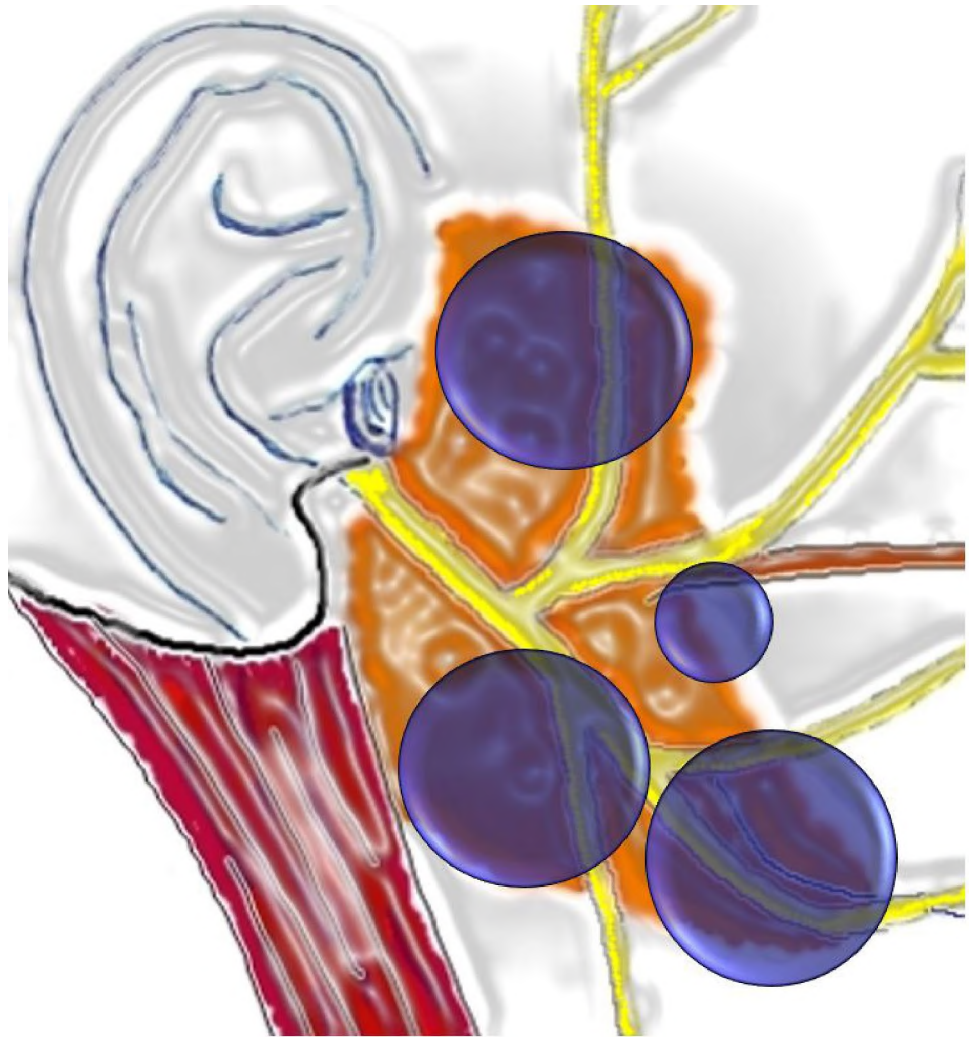


Fig. 6 Surgical site after removal of benign tumor of the anterior part of the left PG. Preserved Stensen's duct (SD) and branches of the FN can be seen

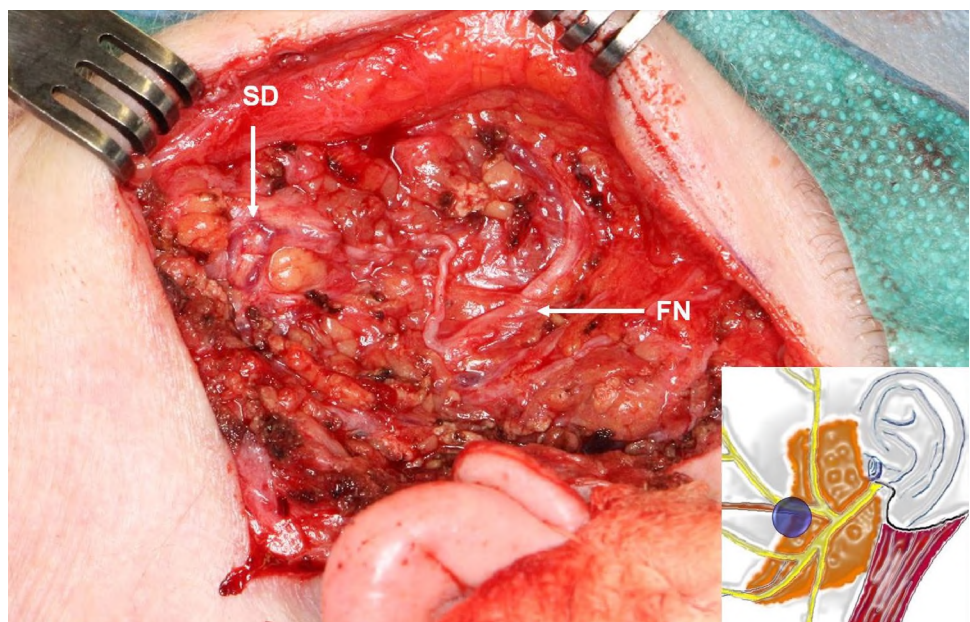
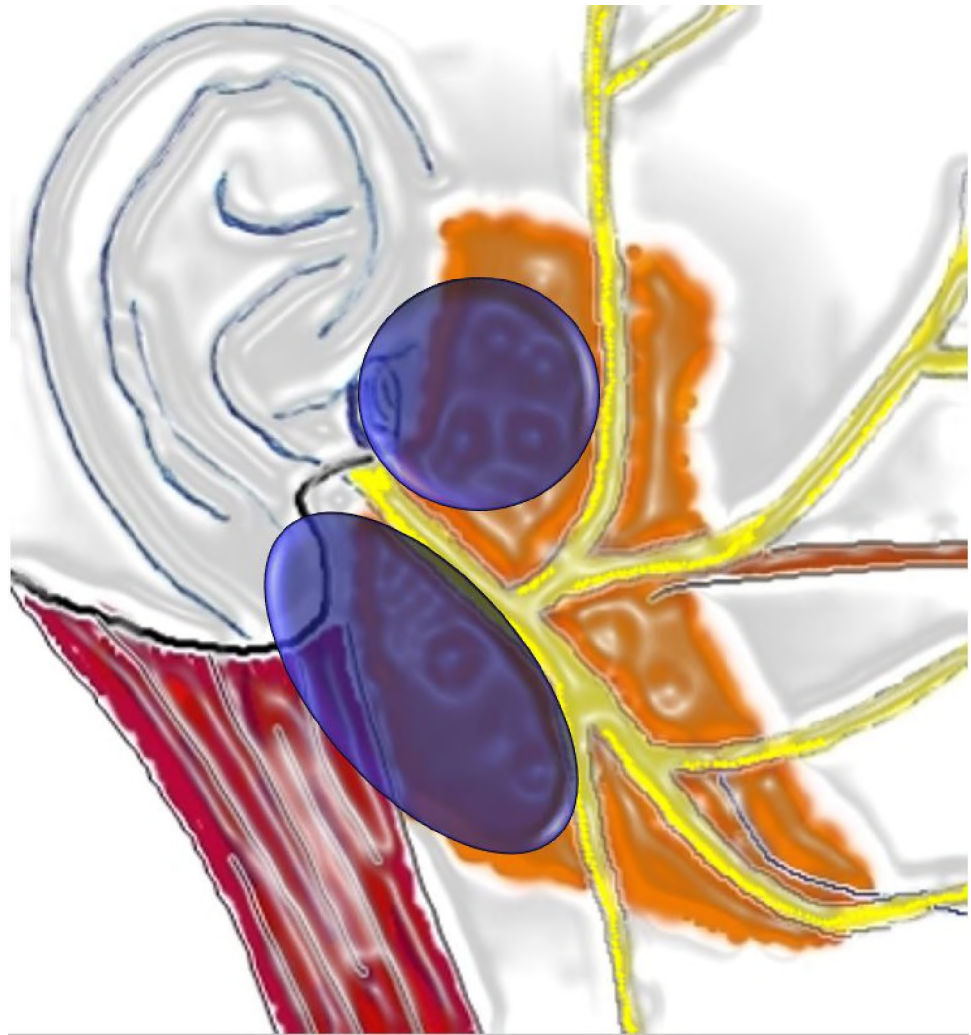


Fig. 7 Location and size of benign parotid tumors representing typical indications for PSP



FN and herniating into the stylomandibular tunnel [69], tumors of the superficial lobe with extension to the deep lobe and multiple tumors of the GP (Figs. 9, 10). Main disadvantages are the higher incidence of temporary and permanent FN palsy, Frey's syndrome, and esthetic deformity [70–72]. Figure 11 shows an algorithm for possible decision making.

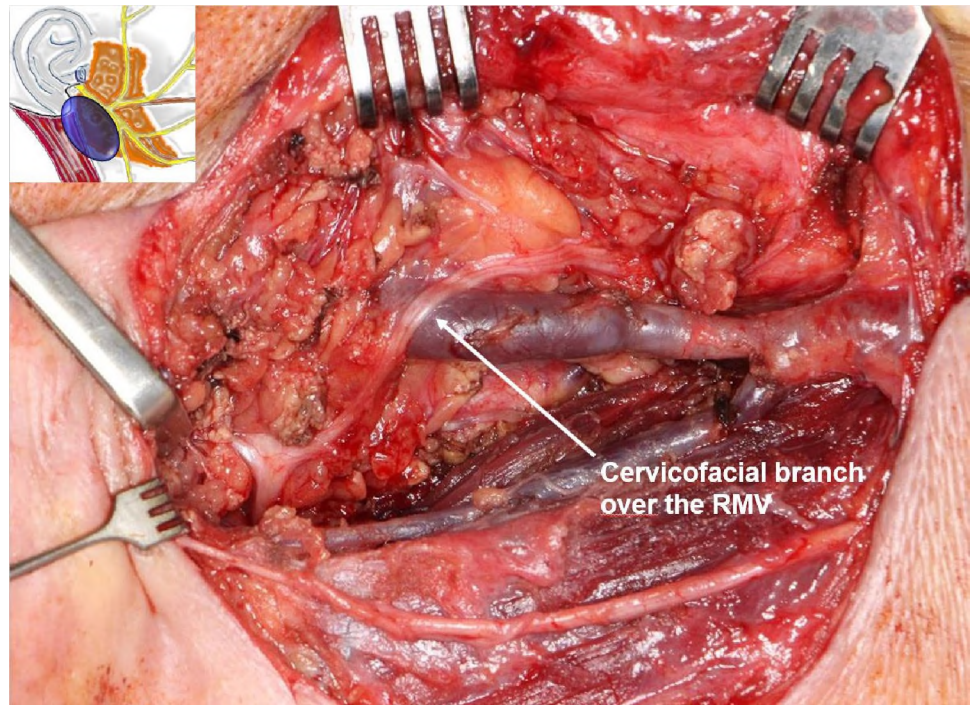
Other factors influencing decision making

The focus of this article was to examine the surgical options of benign parotid tumors according to location, size and proximity to the FN. Of course, other factors can influence decision making in benign parotid surgery too. Possibly histopathology may affect the surgical technique chosen. Warthin's tumors and pleomorphic adenomas are the most common benign parotid gland tumors and account together for more than 70% of all benign tumors [73]. Nowadays Warthin's tumor seems to be the most common benign neoplasm of the parotid gland at least in Germany [73, 74].

Warthin's tumors tend to occur multifocally and if this is the case, usually a subtotal or total parotidectomy is necessary [75]. The most common combination of multiple synchronous parotid tumors are multiple Warthin's tumors, but other combinations are also possible and need to be assessed carefully [76]. Furthermore, Warthin's tumors tend to cause local inflammation that complicate surgery and might necessitate a more extended surgical technique [77, 78].

If PLA is suspected, possible capsular discontinuity, pseudopodia, and tumor satellites increase the danger of recurrence [79]. Being aware of this, careful surgeons may opt for the more extended surgical technique in "borderline" cases with regards to size and location [34, 80]. This may also be the main reason why many surgeons still prefer PSP or SP, as it offers an optimum exposure of the FN in all cases. As a rule which should be furthered to our trainees, every parotid tumor has to be treated with a high degree of caution since a definitive preoperative histological diagnosis is not possible [29]. In cases of recurrent pleomorphic adenomas—which can be very difficult

Fig. 8 Surgical site after removal of large pleomorphic adenoma (>4 cm) of the caudal part of the right PG using PSP. Course of the cervicofacial branch over the retromandibular vein (RMV) and the beginning of the temporofacial branch can be seen



to treat—high degree of expertise and more extended surgical approaches are usually necessary.

Although thorough preoperative assessment can minimize the possibility of unexpected malignancy [30, 81, 82], the possibility of malignant growth should always be kept in mind especially when considering and performing ECD [83]. In cases of preoperative uncertainty, intraoperative frozen section can play an important role [84] because of its high accuracy and can assist decision making and facilitate timely completion of procedures [85]. Initially planned ECD or PSP could be extended in SP or TP if frozen section shows malignancy. One the other hand, it also can mislead and therefore should only be used in selected cases [86]. Tumors of the deep lobe with parapharyngeal extension beyond the stylomandibular ligament (iceberg tumors) represent a separate category and usually require a transcervical or—in very selected cases—a transoral surgical approach [87–89]. At last, in cases of recurrent lesions, especially pleomorphic adenomas that represent a challenge because of multicentricity and risk of further recurrences, high degree of expertise and more extended surgical

approaches are usually necessary [90, 91]. SP and TP represent the techniques of choice in most cases, but limited surgery could also be an option in very selected cases [92–94].

Conclusion

In conclusion, surgeons nowadays have many options to choose from for benign parotid surgery. ECD is one of the many surgical techniques available in parotid surgery and can achieve excellent results with proper training and if used for proper indications. PSP is mainly indicated in large tumors of the caudal part of the PG (ESGS level II). SP represents a universal solution in parotid surgery and should be the first technique young surgeons learn. TP has only few but important indications in benign parotid surgery. Finally, surgeons need to carefully consider the patient and his/her preoperative imaging as well as her or his own special expertise in order to select the most appropriate surgical technique [95].

Fig. 9 Tumor to the deep lobe in proximity to the FN, represent the typical indication for TP in benign parotid surgery

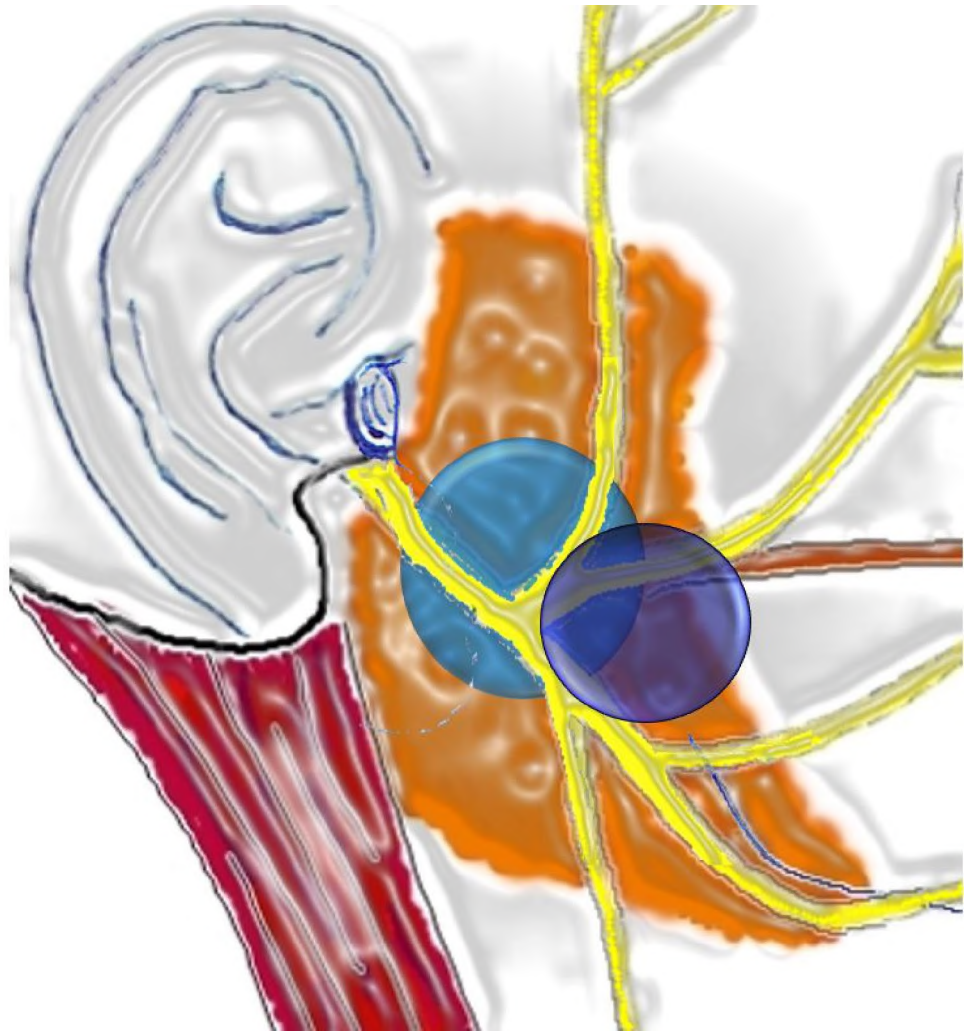


Fig. 10 Surgical site showing a benign tumor of the deep lobe of the left PG that has very close contact to the main trunk of the FN

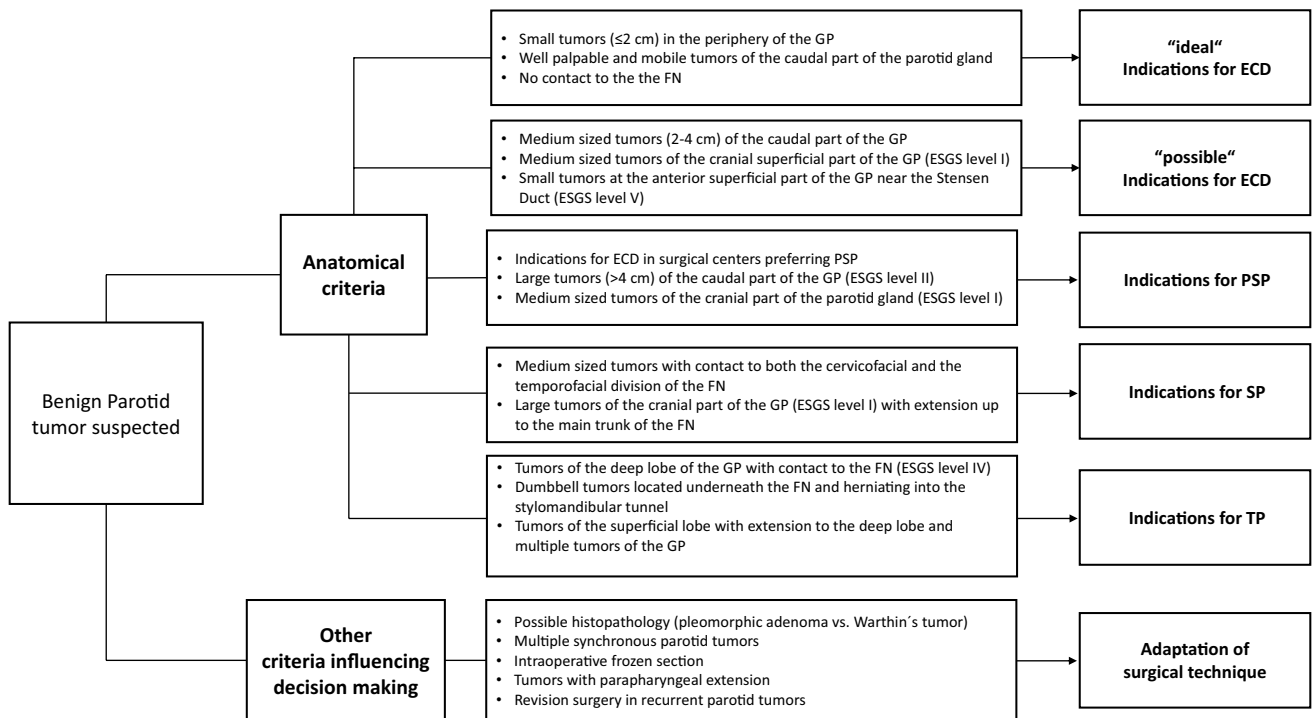
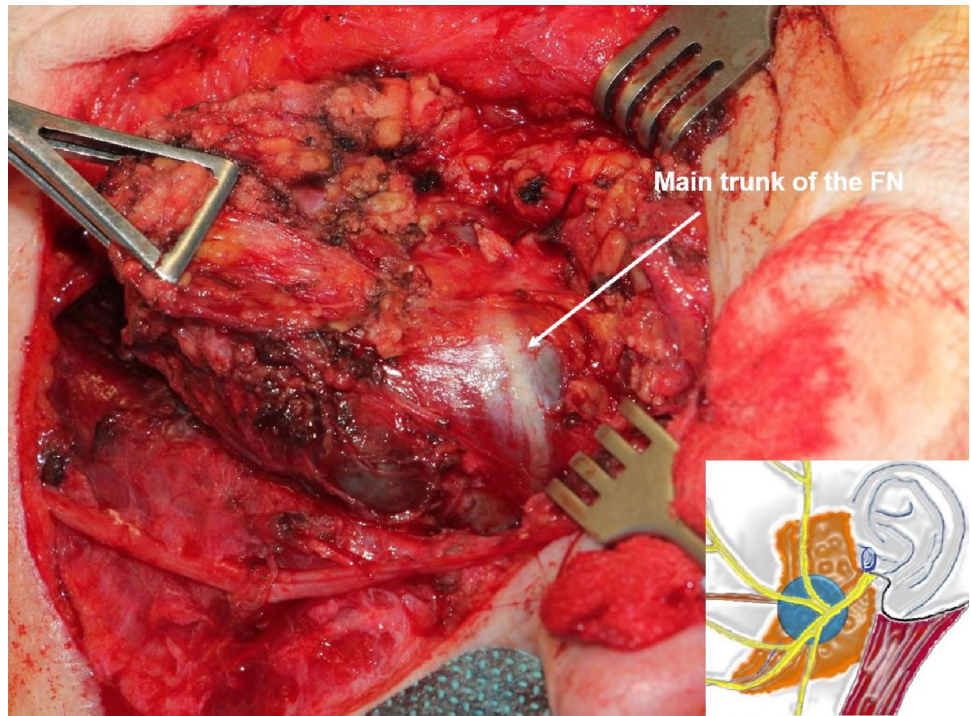


Fig. 11 Algorithm: Anatomical and other criteria influencing decision making in benign parotid surgery

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Compliance with ethical standards

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