The Role of Extracapsular Dissection for Benign Parotid Tumors

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Abstract Surgical treatment of benign parotid tumors has been debated for decades. Extracapsular dissection (ECD) differs markedly from classic surgical approaches to the parotid neoplasm because facial nerve dissection is not performed. ECD, its advantages, disadvantages, indications, and contra-indications for benign tumors with an emphasis on benign mixed tumor will be comprehensively explored in this chapter. Factors noted to favor this approach include mobility of the tumor within the gland, a thin covering of capsule and glandular tissue, and a tumor large enough to allow digital manipulation during dissection. Imaging, fine needle aspiration cytology, and neuro-monitoring play a heightened role in ECD. Recurrence and permanent facial nerve dysfunction with ECD are not higher in high volume centers performed by experienced surgeons. Transient facial nerve dysfunction, Frey's

syndrome, sensory deficits, and sialoceles are lower with ECD. Devastating adverse outcomes of permanent facial nerve dysfunction and recurrence should be considered by the occasional and inexperienced parotid surgeon.

Keywords Extracapsular dissection · ECD: benign mixed tumor · Pleomorphic adenoma · Superficial parotidectomy · Partial superficial parotidectomy

Introduction

Surgical treatment of benign parotid tumors has been debated for decades. There has been a gradual move in surgery away from robust procedures that are reproducible in the hands of the generalist surgeon to ones that can be safely performed by a surgeon with an area of sub-specialty interest. This technique is conceptually different to the classical surgical approaches to parotid neoplasms which are essentially a dissection of the facial nerve. In contrast, extracapsular dissection avoids a formal nerve dissection in preference to a careful dissection around the tumor itself. In this chapter, the role of extracapsular dissection (ECD) will be contrasted to surgical alternatives including complete superficial parotidectomy that removes all parotid tissue lateral to the facial nerve, and partial superficial parotidectomy [1–3], where the trunk of the facial nerve is identified and only limited dissection of the upper or lower branches occurs depending on the site of the tumor together with a cuff of 1–2 cm of normal parotid tumor surrounding the neoplasm. A total parotidectomy involves the removal of all parotid tissue both medial and lateral to the facial nerve. In contrast, ECD involves a careful blunt dissection through the parotid tissue by way of a cruciate incision placed directly over the tumor. The

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neoplasm is then removed with a 2- to 3-mm rim of normal parotid parenchyma surrounding the tumor [4, 5]. It is important to dispel the notion that ECD is a form of enucleation. Enucleation was practiced in the 1900s where the capsule of the tumor was incised and the contents removed leaving the capsule in situ. An ECD removes the whole tumor including its capsule. The application of ECD to benign mixed tumors (BMT) is hotly debated. This technique also has application to other benign parotid lumps such as lymph nodes in children or a Warthin's tumor.

ECD, its advantages, disadvantages, indications, and contra-indications for benign tumors with an emphasis on BMT will be explored in this chapter.

Historical Perspective

To appreciate the current percepts and prejudices in the practice of parotid surgery, it is helpful to trace the evolution of the subject from its beginnings around 1900 when modern parotid surgery began to evolve. Isolated reports of parotid surgery are present in the early literature and it is clear that it was a feared operative procedure. At the turn of the century, patients presented with late disease and indurated masses in the parotid that frequently encompassed the great vessels in the neck. Anesthesia was in its infancy and delivery was via a facial mask until local anesthesia became the norm for parotid lumps. Imaging was not available nor was blood replacement or antibiotics. The topic of salivary pathology was rudimentary. Adequate classification by Ahlbom [6] was published in 1935. Pleomorphic adenoma also posed a diagnostic problem due to their variable appearance (cystic and/or cartilaginous components). They were considered hamartomas (developmental lesions) and not neoplasms. Consequently, surgeons at the time treated these lumps by enucleation. It is in this period, the 1920–1960s, that the pleomorphic adenoma gained its reputation for recurrence. At this time, surgical care fell to the general surgeons. The scope of practice was challenged in that most of the surgery was done under local anesthetic by peripheral nerve blocks. Their work would range from amputations to abdominal surgery and craniotomies all in the same operating list. By the 1920s, there was a conscious effort to spare the facial nerve, and the common technique was to make an incision through the skin directly over the lesion, then scoop out the contents with a spoon or finger, sometimes packing the capsule with a mixture of mercury and hydrochloric acid in alcohol. [7] The indolent nature of pleomorphic adenoma meant that recurrent disease was slow to declare itself, and for a period was not apparent to the surgical community. It was McFarland and others [8, 9] who drew attention to the high rates (~45 %) of recurrence with enucleation and the benign histology of these tumors stating “The complacency

of surgeons is not infrequently disturbed with the return of these patients with the recurrence of the tumor and that of the pathologist by the continued good health of some patients condemned to death upon the histopathological evidence of a supported malignancy”.

With the advent of radium seeds, the new approach was to continue enucleating the tumor core and to lay radium seeds in the wound [6, 10]. In 1907, Carwardine [11] described how to preserve the facial nerve whilst removing the parotid gland. Sistrunk [7] in 1921 and Adson [12] in 1923 refined this technique, using a pre-auricular incision and wide dissection, a method that was further developed by Hamilton Bailey [13] and Hayes Martin [14], who described anterograde dissection of the facial nerve in 1952. The concept took time to be accepted but it gained scientific credibility in 1957 with the publication of a seminal paper published by Patey and Thackray [15]. They undertook a histological evaluation of benign parotid tumors and reported both focal infiltration and pseudopodia projecting through the capsule. It was accepted as axiomatic that these tumor remnants would be left behind by close dissection around the tumor, thereby providing histological evidence that would explain why pleomorphic adenomas were at risk of recurrence. The fact that the appearance of focal infiltration was due to tangential cutting of tumor projections was overlooked. Patey, whose name is mainly associated with mastectomy, went on to set up the Cancer Research Campaign Salivary Gland panel in 1965. As a result of his pathological findings, with limited clinical correlation, he and his co-worker, Thackray, recommended that the best treatment for most forms of parotid tumor was ‘some form of conservative parotidectomy’. The net result of this work was a swing by surgeons to a more expansive procedure in the form of nerve dissection (superficial and total parotidectomy) to give these tumors a wide berth during surgery and leave a significant cuff of normal tissue around their surface. The change in surgical policy coincided with a reduction in tumor recurrence. The perceived link between pleomorphic adenomas and incomplete capsule and recurrence was established. At the time, this debate was evolving in the 1940–1960s, a surgeon at the Christie Hospital in Manchester (Nicholson) was of the opinion that recurrence was not due to the biology of the tumor but the fact that surgeons approached these lumps by incision directly over their surface. This form of exposure led to tumor spillage. He advocated the use of a preauricular skin flap to give access to the tumor but then he proceeded to remove the lump by carefully dissecting through the parotid tissue at 2–3 mm peripheral to the tumor capsule. He was not alone, as Byars [16] in Missouri was practising the exact same technique, making ‘no effort... to enucleate the tumor at the level of its false capsule’ but advocating the taking of ‘a thin layer of

adjacent normal gland'. Byars recognized that the tumor is commonly closely associated with the facial nerve, making wide resection possible only if the facial nerve is 'simultaneously excised'. By the time the debate was settled in favor of superficial parotidectomy, Nicholson had 10 years experience with his approach without recurrence. Consequently, he continued in isolation for the remainder of his career until transferring his knowledge to two other surgeons (Hancock and Gleave). Their collective work of 475 tumors has been published [17]. Nicholson was fastidious in following his patients so that few cases were lost to follow-up the series had a median follow-up of 12 years. The recurrence rate was 1.5 %. Nicholson's notion that the surgical technique was more important than margin around the tumor capsule was not appreciated. Although the traditional superficial and total parotidectomies are still practised, the two main competing operations for BMT today are the partial superficial parotidectomy with ante-grade facial nerve dissection and ECD without facial nerve dissection. ECD in some aspects completes the historical circle with surgical management of benign mixed tumors.

BMT Clinical and Histological Characteristics

Eighty-five percent of BMT present in the parotid gland. Half to two-thirds of parotid neoplasms are BMT. They present in all ages, with the highest incidence in the fourth decade of life. [18] They are firm except in a tumor that is predominantly myxoid (hypocellular). Today, in the developed world, the parotid mixed tumor is most often diagnosed and treated when the tumor is small (<4 cm), mobile, and located in the superficial lobe of the parotid. As 80 % of the parotid parenchyma is lateral to the facial nerve then as a result, 90 % of parotid mixed tumors arise in the superficial lobe, and 80 % are located in the lower pole (Table 1).

Operative decisions require a comprehensive understanding of histological characteristic of this tumor. BMT of the parotid are benign epithelial tumors with an

incomplete fibrous capsule of varying thickness. Macroscopic protuberances give a lobulated appearance as the tumor grows. Tumors may be epithelial cell-rich (cellular) or stromal-rich (myxoid). Tumors are more highly cellular (the epithelial component predominates) in their early stages of development, and the amount of chondromyxoid stroma (the mesenchymal component) increases with the duration of the neoplasm [19]. Recurrent BMT are frequently more hypocellular and myxoid in nature, and these tumors seem to be associated with higher rates of incomplete encapsulation [20, 21]. The inference is that these hypocellular tumors are easier to spill inadvertently during surgery and hence the unexpected miliary recurrence that haunts the parotid surgeon. The perfidious feature of BMT is that the presentation of recurrent disease is unpredictable. It may follow an apparently standard uncomplicated operation. Yet, if the capsule is ruptured during surgery, the incidence of recurrence is only 8 %. [22] The role of the tumor capsule in recurrent disease remains an enigma. There is incontrovertible histological evidence that the capsules of PAs are frequently incomplete, and pseudopodia protruding outside the capsule have been identified as a risk factor for recurrence [23]. It is accepted that up to 60–99 % of parotid tumors lie on a branch of the facial nerve which has to be dissected off the tumor surface leaving a focal area of capsule exposed at surgery [1, 24, 25]. Also after traditional superficial or PSP, 25 % of BMTs are reported to have positive margins [1], yet the rate of recurrence remains low (1.5 % at 7 years) [17]. Historically, the relationship between incomplete capsule and recurrence was drawn from inference. The results can be argued to be different when tested by observation. Close dissection of BMTs during traditional parotidectomy or ECD does not correlate with recurrence. Comparison between PSP and ECD for the amount of normal parotid parenchyma surrounding the BMT after surgery demonstrates 80 versus 21 %, respectively [26•], but this has no effect regarding recurrence in large volume centers (1.5 % at 7 years) [17]. The capsule is not the complete answer to the question of recurrence.

ECD Surgical Technique

The indications for ECD vary with experience. The data from Erlangen show that, over a period of 10 years, the incidence of benign tumors treated by ECD rose from 5 % to approximately 65 % of cases treated (Fig. 1). In the last 10 years at Guy's Hospital, all benign tumors have been treated by ECD. The tumor for which ECD is ideally suited is one that is well defined, mobile, approximately 2 cm in diameter, and lies in the superficial lobe of the parotid gland (Table 1). These are all clinical features of a benign parotid mass that should be corroborated by fine needle

Table 1 Ideal criteria to avoid an adverse outcome using ECD

1.	Benign tumor by fine needle aspiration cytology
2.	Mobile neoplasm
3.	Neoplasm <4 cm
4.	Neoplasm in the superficial lobe
5.	Neoplasm in the tail of parotid
6.	Nerve integrity monitoring
7.	Palpable extent of tumor appreciated
8.	Surgeon trained to convert the procedure to a facial nerve dissection technique if necessary
9.	Experienced parotid surgeon
10.	High volume parotid surgeon

Fig. 1 Application of ECD within a high-volume salivary gland center

aspiration cytology (FNAC) prior to surgery. Paradoxically, it can be the small lump that should be avoided (<1 cm). The inclination when commencing a new approach to a procedure is to select a less demanding case on the first occasion and small tumors are perceived as such. But the main threat to the adoption of ECD by the surgical community is not tumor recurrence but rather inadvertent selection of low-grade malignant lesions masquerading as a benign parotid mass. Small indolent tumors have not had time to declare their clinical nature. The risk of encountering a low-grade malignant tumor potentially increases as the size of the tumor reduces. The positive message from the Christie data is that patients with low-grade malignant salivary cancers (indistinguishable from benign tumor) are indolent and recurrence is uncommon. Selected patients are treated with additional surgery, which remains lower risk as the facial nerve has not been dissected. Radiation therapy is also a therapeutic option in selected patients. [27].

The surgical preparations do not differ between extracapsular dissection and conventional parotidectomy. The skin incision (Blair) and the flap size may be adapted to the size and location of the tumor (Fig. 2). The incision is normally more conservative with ECD. After dissection of the subcutaneous tissue, the sternomastoid muscle and the greater auricular nerve together with the capsular of the parotid gland are exposed (Fig. 3). Before the parotid parenchymal fascia is opened, the tumor is once again palpated to ensure that it is free and there is no suggestion of infiltration and tethering that would raise the prospect of a malignant tumor. A useful technical adaption, when tumors are present in the lower pole of the parotid, is to release the parotid from the sternocleidomastoid muscle by dissection below the deep cervical fascia (Fig. 4). This allows the parotid gland to be rotated forward so exposing the posterior and deep surface of the gland as far as the posterior belly of the digastric muscle. This gives much

improved access for ECD. If the exact position of the tumor cannot be determined, an intraoperative ultrasound scan can be performed. A cruciate incision is then marked over the surface of the parotid lump extending approximately 1 cm peripheral to the tumor margin. This is an important technical point; the incision should not stop at the tumor margin but extend for at least 1 cm peripheral to it. This gives much improved access during the dissection. Four artery clips are applied to the parotid fascia at the centre of the cruciate incision and used to retract the parotid fascia, and with it the underlying parotid tissue is drawn away from tumor. This is an important technical point for with this tension, tissue planes start to appear which direct the line of dissection. Meticulous hemostasis is important and is complemented by careful blunt dissection through the parenchyma until the tumor becomes apparent (Fig. 5). This form of dissection is familiar to parotid surgeons, as it is the technique that is used when searching for the trunk of the facial nerve. As the parenchyma is carefully dissected under tension of the artery clips, the tumor is gradually separated from the underlying parenchyma. With this technique, a small rim of healthy glandular tissue is left on the tumor. The facial nerve is not placed at risk with this technique in experienced hands as the facial nerve appears in the surgical field as the glandular tissue is parted. The tumor itself can then be rolled from side to side as the dissection proceeds. The tumor should be retracted by finger pressure alone; retractors may be applied to the parotid gland but not the tumor for fear of rupture. After the tumor has been released from the surrounding tissue, the edges of the cruciate incision are reapproximated and sutured together (Fig. 6) [28]. Draining the wound is optional, but the use of pressure dressings in the form of modified mastoid dressings is recommended by some but not all surgeons [26]. The pressure dressing potentially reduces the incidence of sialoceles and should be retained for 48 h if possible. In appropriate patients and

Fig. 2 ECD skin incision **Fig. 3** **a** Great auricular nerve is exposed and often preserved. **b** Cruciate incision extends 1 cm beyond the palpated tumor margin **Fig. 4** Release of parotid from sternomastoid muscle (**a**, **b**)

Fig. 5 Blunt dissection through the parenchyma until the tumor becomes apparent (**a, b**)

Fig. 6 **a** Reapproximation of cruciate incision. **b** Closure of the wound

tumors, the ECD operation can be undertaken as a day-case procedure.

Imaging, FNAC, Neuromonitoring

ECD should be considered for mobile, superficial tumors not less than 1 cm in diameter and the upper size limit is optional. Experienced surgeons appreciate that a large benign neoplasm (~8–10 cm) even with traditional superficial parotidectomy becomes an ECD.

Imaging beyond ultrasound is optional for tumors with benign characteristics. Fine-needle aspiration cytology (FNAC) can be debated if the accepted minimal operation is complete superficial parotidectomy. FNAC plays a heightened role in minimal margin surgery including PSP and ECD. FNAC aims to exclude malignancy prior to selection of minimally invasive approaches including ECD.

False negatives (benign FNAC and histopathologic confirmation of malignancy) range from 4 to 7 %. [29, 30] Minimal margin ECD procedures selected because of benign FNAC will encounter an occasional frozen section and final pathology of malignancy. ECD can be converted to a facial nerve dissection procedure in circumstances where the frozen section dictates. Thus, the surgeon performing ECD must also be well versed in facial nerve dissection techniques. As most tumors lie on one or more branches of the facial nerve, even a superficial parotidectomy may not produce an adequate clearance in such circumstances, and adjuvant radiotherapy can be indicated in selected cases irrespective of the operative technique deployed.

Facial nerve monitoring with traditional nerve dissecting techniques has not improved the functional outcome of the nerve after surgery [31, 32]. ECD does not include the

initial identification and control of the facial nerve, and therefore facial nerve monitoring should be considered as an adjunct to this technique.

Recurrence Risk for BMT

In most series, parotidectomy with facial nerve dissection results in recurrence rates of 0–4 %. [1] Recurrences generally occur in the first 10 years, with a mean interval to the first recurrence of 7 years [33]. Recurrent mixed tumors are almost always multinodular [34, 35]. Imaging studies (ultrasound and MRI) coupled with clinical examination are more accurate than clinical examination alone. Historically, the chief cause for tumor recurrence was enucleation [1, 33, 36] due to retention of capsular components. In contemporary practice, it is the older, hypocellular tumors (myxoid-type tumors) which are more delicate and prone to rupture [20, 21]. These hypocellular tumors show greater focal absence of encapsulation (compared with cellular tumors), and merge into normal parotid gland tissue in 70 % of cases [21]. One must interpret these histological findings in the light of reports of series with greater than 400 cases (with a range of histological features) treated by ECD where the recurrence rate was 1.5 % [17].

The other major significant reason for recurrence is tumor rupture and spillage, regardless of histological BMT subtype. Surprisingly, following enucleation where tumor capsule and contents are left in situ, the recurrence rate is only 30–45 % [8, 9]. In a review of 23 publications with 2,366 total patients, the overall rate of recurrence during superficial parotidectomy is 2.6 %. When the capsule is ruptured using superficial parotidectomy with facial nerve dissection, the rate of recurrence increases to 5 % ($p < 0.05$) [1, 22]. Tumor spillage does not lead to inevitable tumor recurrence.

The rate of recurrence for ECD compared to complete superficial parotidectomy has been studied in a meta-analysis which demonstrated a similar rate for both these techniques [1]. A series from a high volume parotid center reports a non-significant difference in capsule rupture comparing ECD and superficial parotidectomy (3.4 vs. 1.8 %; $p = 0.1$) [37]. In a series of 76 patients with pleomorphic adenomas, treated by ECD and followed for a mean of 7.4 years, no recurrences were observed [38•]. In a series of 176 cases followed for 52 months, the rate of recurrence comparing ECD and superficial parotidectomy was 4.5 versus 3.6 % [37], and in a further series of 156 patients followed for a mean of 3 years and 8 months, there were no published cases of recurrence [39•]. Against this pattern, there are isolated reports of increased rate of recurrence of up to 8 % with ECD [40]. In this series, an

explanation was given by the principal author (personal communication) for the higher rate of recurrence. The surgeons were trying to access the tumor by an incision made through the skin over the surface of the tumor. This is reminiscent of Nicholson's explanation for why there were higher recurrence rates in the 1920s and 1930s [41].

The relevance of published recurrence rates is difficult to gauge, as the average time to first recurrence is 7 years and studies require long-term follow-up. Although the risk of recurrence with ECD in high volume parotid centers does not appear to be greater than traditional nerve dissection techniques, further long-term prospective studies are required to confirm this. One main concern following tumor recurrence relates to the facial nerve. The facial nerve is eight times more intimately bound to the tumor [42], and consequently facial nerve injury occurs in up to 40 % of cases. The rate increases with each revision procedure [43]. The potential devastation of recurrent disease cannot be underestimated. One-third of patients with recurrent tumors do not achieve tumor-free status [44].

Permanent Facial Nerve Dysfunction

Permanent facial nerve dysfunction is reported in 0–4 % of cases following facial nerve dissection procedures [45–47]. A meta-analysis showed twice the chance of permanent facial nerve dysfunction with ECD compared with superficial parotidectomy and a three times higher chance following total parotidectomy compared to superficial parotidectomy [1]. However, the incidence of injury following ECD returns to expected incidence (2 %) in high volume centers [28], [39•]. ECD performed by experienced surgeons is not associated with higher risk of permanent facial nerve dysfunction compared to superficial parotidectomy. Whether the incidence of facial nerve injury will increase whilst surgeons gain experience with the technique remains to be seen.

Temporary Facial Nerve Dysfunction

Meta-analysis summary effect for transient facial nerve dysfunction shows a 2.3 times higher incidence with total parotidectomy compared with superficial parotidectomy and 2.0 times higher with superficial parotidectomy compared to ECD. The incidence of transient dysfunction averaged 30 % for TP, 25 % for SP, 18 % for PSP, and 11 % for ECD [1]. Improved results are reported in high volume centers undertaking ECD with rates of 3–6 % transient nerve dysfunction [28], [39•] compared to 16 % using PSP [48]. ECD offers an advantage over PSP as the facial nerve is not dissected and so the risk of stretch injury and inadvertent pressure effects are reduced.

Frey's Syndrome

Frey's syndrome is reported in a questionnaire survey as the most disturbing sequel to patients more than 5 years post-parotid surgery for benign disease [49]. Meta-analysis summary effect for Frey's syndrome has been reported as up to 10 times more common with superficial parotidectomy compared to ECD, presumably because less parotid is dissected and the damaged tissue is sealed into position once the parotid fascia is re-approximated through closing the cruciate incision [50]. The incidence of Frey's syndrome averaged 47 % with total parotidectomy, 17 % with superficial parotidectomy, 10 % with PSP, and 3 % with ECD [1]. The evidence shows that ECD offers a clear advantage in terms of Frey's syndrome compared to nerve dissection techniques.

Sensory Deficit in the Great Auricular Nerve

Preservation of the posterior branch of the great auricular nerve can reduce sensory deficits in up to half of patients undergoing facial nerve dissection parotidectomy [3]. ECD has been reported to have a rate of sensory deficit of 5–10 % [28], [39]. Most ECD procedures do not transect any branches of the great auricular nerve, whereas all facial nerve dissection procedures including PSP will transect at least the anterior branches. Reduction of sensory deficit is a clear advantage of ECD, but this advantage is obviously dependent on the position of the tumor. Warthin's tumors which lie in the tail of the parotid can be positioned where the great auricular nerve enters the parotid fascia, and in such circumstances the nerve can be difficult to preserve.

Sialocele

Sialocele and fistula have been reported in 4 and 5 % [28, 51] in a series on ECD with a fistula rate of 2 % [28]. Sialocele has been reported as high as 39 % in PSP although resolution without treatment occurred in all cases within 4 weeks [52]. Reduction in sialocele is a clear advantage of ECD, and the risk of sialocele may be reduced with the use of a pressure dressing. If this condition does occur, one treatment option is hyoscine tablets (10 mg qds). The saliva can be aspirated at intervals and a pressure dressing reapplied. These three actions will reliably eliminate sialocele in 10–14 days. Alternatively, if left untreated, sialocele will generally resolve without treatment within 1 month [52].

Conclusions

In most traditional facial nerve dissection parotid procedures, the capsule of the parotid tumor is exposed during the

operation without an increased risk of recurrence. Prolonged follow-up (median 12 years) demonstrates that ECD in reported series does not increase the incidence of recurrence compared to superficial parotidectomy (1.5 % at 7 years). Permanent injury to one or more branches of the facial nerve is similar with these two techniques (2 %) in high volume centers. The real advantage is the reduction in transient nerve injury with ECD. Frey's syndrome, greater auricular nerve neuropathy and contour defects are minimized with ECD. The question remains whether this is an exportable technique. The evidence from surgical units at Erlangen and Guy's Hospital suggests the technique can be safely transferred to a new generation of surgical trainees, who can optimize their learning curve in high volume centers.

Compliance with Ethics Guidelines

Conflict of Interest Robert L Witt, Heinrich Iro, and Mark McGurk declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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