Neck dissection

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Introduction

Many of the surgical principles described in this chapter have not changed significantly since 1906 when Crile published his classic paper describing 132 neck dissections (36 radical and 96 more selective procedures). Only 2 years later, Sir Henry Butlin described a procedure that is essentially the same as a current supra-omohyoid neck dissection (SOHND). Despite this publication of a ‘selective’ neck dissection, most elective treatment of even the clinically negative (N0) neck during the first half of the 20th century consisted mainly of radical neck dissection (RND). Over the last 20 years, there has been an increasing trend towards selective neck dissection (SND) for the initial management of patients with no clinical evidence of neck metastasis, and in carefully selected patients with nodal metastasis (although its use in the latter remains controversial).

Whilst SND preserves many vital structures (such as the accessory nerve), the functional results after these procedures are not as good as expected. Shoulder function and pain scores are worse in patients who undergo posterior triangle dissection, which may not recover despite preservation of the accessory nerve. A study has found that the variables that contribute most to quality of life scores relating to the neck were age and weight, radiotherapy to the neck and type of neck dissection.

Neck dissection classification

Neck dissection nomenclature can be confusing. It can be simplified as follows:

- **Radical neck dissection.** This refers to removal of lymph nodes in levels I–V en bloc with the sternomastoid muscle, also known as sternocleidomastoid muscle (SCM), internal jugular vein (IJV) and spinal accessory nerve. This operation is both cosmetically and functionally mutilating and is used in gross metastatic disease, involving multiple levels of the neck and when preservation of the above structures would compromise surgical clearance. Although this operation has been regarded as the ‘gold standard’ for the surgical treatment of metastatic neck disease, it has largely been replaced by more selective surgery.

- **Modified radical neck dissection** (MRND) refers to dissection of levels I–V but with the preservation of one or more of the following structures: IJV, spinal accessory nerve and sternomastoid. The nomenclature refers to the number of structures preserved (so MRND type I is preservation of one of these structures, MRND type II is preservation of two structures and so on). Both RND and MRND are used when the neck has evidence of nodal metastasis (N+), although there is growing evidence to suggest that the more SND (see below) has a role to play not only in staging but in the management
of the N+ neck as well. The reader is referred to an excellent recent review of this subject by Ferlito et al.

### Selective neck dissection

In 1991, the Committee for Head and Neck Surgery and Oncology of the American Academy of Otolaryngology and Head and Neck Surgery indicated that 'in all SND, the IJV, spinal accessory nerve and SCM are routinely preserved. If removal of one or more of these structures is necessary, the structure should be listed after the appropriate term for the neck dissection'. As a result, SND can easily be confused with MRND and indeed some surgeons use the terms interchangeably. However, SND should refer to the dissection of one or more levels of the neck (with careful preservation of the anatomical structures listed above, as well as other nerves such as the marginal mandibular branch of the facial nerve) rather than all five levels. Examples include the SOHND, (levels I–III), lateral compartment neck dissection (levels II–IV) and levels I–IV neck dissection.

### Terminology of neck levels

The most significant change to the well-known Robbins classification was the publication of an updated system in 2002. In addition to the five standard levels, nodal levels were subdivided into levels IA and B, IIA and B (below and above the accessory nerve) and VA and B (above and below the accessory nerve in the posterior triangle) (Figure 41.1). The concept of sublevels is clinically relevant since metastasis to level IIB from anterior oral cavity tumours is uncommon and metastases to level VA is rarer still, with studies advocating that the dissection of these levels is not usually necessary.

### Principles of surgery

The rationale for neck dissection is based on predictable patterns of lymphatic spread from the primary tumour site, and the relative risk of nodal metastatic disease. Over 30 years ago, Lindberg’s clinical study found that the jugulo-digastric and mid-cervical nodes (levels II and III) were the most frequently involved in metastatic disease from the oral cavity. Tumours of the lip, anterior two-thirds of the tongue, floor of mouth and buccal mucosa also metastasize to the level I nodes (submental and submandibular triangles), often bilaterally. Lindberg described the possibility of skip metastasis, avoiding the first echelon nodes and spreading directly to the level III area. More recent studies have found that when levels I–IV are negative and level V is never node positive, supporting the use of the SND for the N0 neck. Despite many published studies, there is still controversy about neck dissection surgery and the reader should refer to specialist textbooks for a full discussion.

When taking trainees through a neck dissection, the author makes the analogy of walking through a jungle. Some structures in the neck (such as the digastric and omohyoid muscles) will help to delineate the path – these are your trusted guides. However, you will also come across many dangers, which if not treated with respect could take you by surprise, sometimes when you least expect it! These include structures such as the phrenic, hypoglossal and marginal mandibular nerves.

### Technique

#### Patient position

1. For all neck dissections, the fully anaesthetized (but unparalysed) patient should be placed supine on the operating table with the head turned away from the side being operated. A sandbag can be used if required to elevate the shoulder. It is sensible to expose the neck from the sternum and lateral clavicle to the ear and lips. Following skin preparation, the drapes need to be secured in place using adhesive strips, sutures or skin clips. It is useful to keep the lower lip exposed (to check for marginal mandibular nerve function).

2. **Choice of incision.** This depends on the type of neck dissection being undertaken. Ideally, skin incisions should be placed in natural skin creases, following Langer’s lines. The lower border of the mandible, sternomastoid and clavicle can be marked to assist placement of the incision. For a SND, an incision running...
from the mastoid to submental area 3 cm below the mandible is usually adequate. When levels IV and V are being dissected, it may be necessary to place a second incision to gain access to these areas. The author routinely uses a Schobinger-type incision for MRND (Figure 41.2), except in the previously irradiated neck, where a MacFee incision is preferred (to reduce the risk of wound dehiscence). When a Schobinger incision is used, it is important not to place the tri-radiate part of the incision over the great vessels, especially if the sternomastoid is removed (risk of wound infection and vascular compromise!). If a MacFee incision is used – this is the correct spelling of the author who described it in 1960 – some spell it McFee! – an adequate bridge of skin between the incisions (of at least 4 cm) is essential to minimize the risk of skin necrosis (Figure 41.3). It is important to mark either side of the incisions (using needle and Bonney’s blue, or superficially scoring the skin with the back of a scalpel blade) to facilitate subsequent skin closure.

3. Development of skin flaps. It is usual to raise skin flaps in a subplatysmal plane. Local anaesthetic solution may be injected to facilitate this process. The flaps can be raised using monopolar diathermy (Colorado needle), scalpel or scissor dissection. With all of these techniques, but particularly when diathermy is used, care should be taken in the upper skin flap to minimize damage to the marginal mandibular nerve, which lies just deep to the platysma muscle in the deep cervical fascia. It can be readily identified as it crosses the facial vessels (FVs) and great care should be taken to preserve this nerve. It is sometimes possible to preserve the great auricular nerve as it crosses the SCM although the roots (C2,3) are often transacted later on in the dissection. In both the submental and posterior triangles, the platysma muscle often fades away and care should be taken to ensure that the skin flap does not become too thick or thin in these areas. It is sometimes surprising just how superficial the accessory nerve can be! The external jugular vein is easily damaged when the inferior skin flap is being raised as it lies immediately deep to the platysma muscle and may need to be ligated. The flaps should be developed beyond the boundaries of the neck dissection to be performed. For a MRND, the flap should be extended to the trapezius muscle in the posterior triangle. The muscle can be brought into view by having an assistant pushing it upwards and forwards. In bulky disease, it may be necessary to leave the platysma on the metastatic nodes, or even include skin in the resection if clinically indicated. In these cases, it is important to plan skin incisions to facilitate subsequent closure.

**Figure 41.2** Schobinger incision for modified radical neck dissection (MRND).

**Figure 41.3** MacFee incision. Distance between incisions should be at least 4 cm.
4. **Start of neck dissection proper: I–IV SND.** Where should I start the neck dissection? This is a question often asked by newcomers to this procedure. There are many ways to perform the procedure (inferiorly to superiorly, posterior to anterior and so on) and it is often good to try different methods and to vary these on separate occasions to find a way that works for each operator. Even then, one’s routine procedure may need to be modified when, for example, a large metastasis is present in level II, in which case it is often wise to start somewhere else. Also, if one particular area is proving difficult, move on to another region and come back to it. The procedure described below is for a level I–IV SND. The RND and MRND variations are discussed subsequently.

5. **Mobilization of the SCM.** The fascia overlying the SCM is incised along the whole posterior margin length of the muscle and lifted anteriorly. The dissection is continued close to the muscle in a broad front inferiorly and superiorly around its anterior border. Superiorly, the tail of the parotid and the posterior digastric muscle will come into view on its way to the mastoid process. The SCM is then retracted posteriorly, and the carotid sheath will come into view, initially with the IJV (Figure 41.4). By maintaining a broad front, the SCM can be skeletonized away from the underlying deep structures. It can then be retracted with vascular slings. The omohyoid muscle will be seen inferiorly, the tendon of which passes superficial to the IJV. This muscle arbitrarily divides the ‘surgical neck’ into levels III and IV, although the position of the muscle varies with neck position. For a level IV dissection, the omohyoid is dissected free from the IJV, whereas in a SOHND, the dissection commences superiorly to the upper border of this muscle. As one dissects superiorly, the accessory nerve will be found deep to the posterior digastric passing in a medial to lateral direction into the anterior border of the upper third of the SCM. It can often be felt as a cord like structure. By hugging the anterior border of the SCM in a broad front, this important nerve is easily identified. It is worth noting that this nerve has many anatomical variations (one can be seen in Figure 41.5), and it can pass superficial, deep or even through the IJV.

6. **Clearance down to pre-vertebral fascia.** The fatty tissue containing nodes posterior to the IJV is carefully incised at the inferior extent of the dissection in a horizontal direction. This is done in stages, so as not inadvertently go through the thin pre-vertebral fascia. The use of scissor dissection combined with the intermittent use of a wet swab to sweep this tissue off the pre-vertebral fascia enables easy identification of this fascia. The phrenic nerve will be seen under the pre-vertebral fascia passing from lateral to medial on the scalenus anterior muscle (Figure 41.6). More laterally at the root of the neck, the upper trunks of the brachial plexus may also be visualized, again under the fascia.

![Figure 41.4](image1) Dissection around sternomastoid muscle (SCM) to reveal internal jugular vein (IJV). The accessory nerve is just coming into view (arrowed).

![Figure 41.5](image2) Identification of the accessory nerve. In this case, a variant with innervation from a cervical plexus nerve.

![Figure 41.6](image3) Clearance in level IV. The phrenic nerve under the pre-vertebral fascia is arrowed.
The author routinely extends this dissection laterally to the area over which lies the posterior border of the SCM (effectively including the anterior border of level V in the dissection). Once the correct depth has been established, it is quite easy to carry the postero-lateral part of this dissection in a superior direction. This can be facilitated by appropriate retraction and counter-traction. As the dissection proceeds in this way, one will come across cervical nerves that have pierced the pre-vertebral fascia. These can be cut as long as they are superficial to it and the phrenic nerve has been identified. In some cases it is possible to preserve some of these nerves, thereby maintaining sensation to the skin in the dermatomes supplied by them. As one reaches the accessory nerve superiorly, the sternomastoid is retracted fully, and the level IIb can be cleared down to the muscular floor. The anatomical variations of this nerve should be remembered (it can be anterior [most common] or posterior to the IJV, or even pass through the vein). Level IIb contains the occipital artery, which runs posteroinferior to the posterior digastric muscle. Once cleared, the fatty tissue can be passed under the accessory nerve in continuity with the neck dissection specimen.

7. Dissection and clearance around the great vessels. The dissection now proceeds anteriorly onto and around the IJV. The fascia overlying the posterior aspect of the IJV is incised in a broad front (superiorly and inferiorly), and dissection is carried around the IJV itself. With a left-sided neck dissection and when approaching the IJV inferiorly in level IV, an attempt should be made to identify the thoracic duct on its posterior surface. It is also vital to identify the vagus nerve (Figure 41.7), which usually lies between the IJV and common carotid artery. Superiorly, the hypoglossal nerve will be seen crossing the internal and external carotids. It gives a descending branch (C1) which joins with C2,3 to form the ansa cervicalis. This nerve usually lies antero-lateral to the IJV and should be preserved if possible (if only to show off one’s technical expertise!). The sympathetic chain can sometimes be seen on the pre-vertebral fascia deep to the carotid artery, although the dissection itself should not be deeper than IJV.

8. Anterior dissection. The limits of the anterior dissection are the anterior border of the omohyoid, and the midline of the neck in the submental triangle. The dissection can proceed quite quickly up the omohyoid muscle. Occasionally a large vein is identified (sometimes after it has been cut!) but this is readily ligated. As the dissection reaches the inferior part of the hyoid bone, care should be taken to re-identify the hypoglossal nerve as it passes into the submandibular triangle. The dissection can now continue from the midline along the lower border of the mandible. The mandibular periosteum can be incised to create a sharp plane of dissection. The submental area is usually quite vascular, due to many branches of the submental vessels. The bleeding is usually controlled with diathermy.

9. Submandibular triangle. As the dissection passes along the mandible, the mylohyoid muscle will come into view. The marginal mandibular branch of the facial nerve should be identified (if this has not already been done) and retracted. The FVs can be ligated and retracted superiorly to assist retraction of this nerve (Figure 41.8). Having dealt with these structures, it is easy to retract the mylohyoid, exposing the floor of mouth, and enabling easy removal of the submandibular gland (Figure 41.9). The lingual (superiorly) and hypoglossal nerves (inferiorly) should be identified in the floor of mouth and the submandibular ganglion and duct ligated and divided. At the posterior aspect of the gland lies the facial artery, which loops over the posterior digastric and this requires division. If possible, when a microvascular reconstruction is taking place, this artery should be left as long as possible to facilitate subsequent anastomosis. All that remains is

**Figure 41.7** Further dissection reveals the vagus nerve and ansa cervicalis (arrowed).

**Figure 41.8** Marginal mandibular branch of facial nerve. The facial vessels (FV) have been ligated. DG, digastric tendon.
to join up the posterior part of the submandibular triangle with the level II dissection. The tail of the parotid can be included here, and the retromandibular vein will need to be ligated. The specimen should be suitably orientated for the pathologist.

10. Drains and closure. Meticulous haemostasis is paramount for this procedure – the patient should be positioned head down to increase venous pressure to visualize bleeding points. A Valsalva manoeuvre given by the anaesthetist to further increase venous pressure is also often helpful. Two large drains (size 16) should be placed. The author routinely uses 3/0 Maxon to close platysma, with either 5/0 Prolene or skin clips to close the skin itself.

Variations – MRND and RND

1. In many respects, the removal of the SCM makes the neck dissection much easier, although adds morbidity for the patient. With a RND or MRND (when the SCM and IJV are included), the SCM can be cut through superiorly and inferiorly using monopolar diathermy. The IJV itself requires careful ligation both superiorly and inferiorly. The author places two 2/0 linen ties with a 3/0-silk transfixation suture between them on the IJV being left. On the part of the vein being removed, it is wise to place a transfixation suture as well, since the ties sometimes come off during the dissection giving an unexpected shock. Since it is low pressure in the IJV, any bleeding can be tempoarily arrested with pressure. If a tie came off superiorly at the skull base, it should still be possible to control bleeding with pressure (even suturing packs in place). Once the SCM and IJV are divided, it is easy to use the cut omohyoid muscle belly to rapidly progress the dissection anteriorly. Ideally if possible, the accessory nerve should be preserved in a MRND as should the marginal mandibular nerve (Figure 41.10).

2. Level V can be cleared starting initially inferiorly along the clavicle, again down to the level of the pre-vertebral fascia. Large clips (e.g. Roberts) can be used to clamp the fat (and transverse cervical vessels). These are ligated as one proceeds with the dissection. At this point, care should be taken not to inadvertently pull up the subclavian vessels! This can be prevented by initially dissecting straight down through the fat onto the pre-vertebral fascia. It is also possible to damage the lung apex resulting in a pneumothorax, although this is rare. The accessory nerve can be dissected free and skeletonized from the fat if this nerve is being preserved. The cervical nerves will need to be cut to enable removal of level V, but remember that these should only be cut when they are superfi-cial to the pre-vertebral fascia. It may be necessary to cut the inferior belly of the omohyoid.

Supra-omohyoid neck dissection

The principles of a more selective procedure are the same as for the levels I–IV neck dissection described above, although it can be technically more challenging. The dissection usually starts inferiorly over the omohyoid muscle and proceeds superiorly as before. As with a levels I–IV neck dissection, it is important to mobilize the SCM muscle and take the dissection posterior to the IJV to sample as many nodes as possible.

Effects of radiotherapy

Surgery become more difficult in the irradiated neck, and it is often more difficult to preserve structures, particularly nerves such as the accessory nerve. Tissue planes are distorted, fibrosis makes dissection much more difficult, and bleeding from small vessels can also be a problem. Furthermore, there is a greater chance of wound breakdown (Table 41.1).
Table 41.1  Complications of neck dissection.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Immediate</td>
<td>Packing, identify vessel, repair if appropriate (involve vascular surgeons if common or internal carotid [rare])</td>
</tr>
<tr>
<td></td>
<td>Chest drain</td>
</tr>
<tr>
<td></td>
<td>Oversee with 3/0 silk. Use sternomastoid or omohyoid</td>
</tr>
<tr>
<td></td>
<td>Micro-neural repair</td>
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<tr>
<td></td>
<td>May need tracheostomy</td>
</tr>
<tr>
<td>Early</td>
<td>Exploration and/or medium chain triglyceride (dietician support)</td>
</tr>
<tr>
<td></td>
<td>Evacuate depending on size</td>
</tr>
<tr>
<td></td>
<td>Systemic antibiotics/drain if collection</td>
</tr>
<tr>
<td></td>
<td>Minimize risk with initial choice of incision and two-layer closure</td>
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<tr>
<td></td>
<td>Re-suturing in theatre</td>
</tr>
<tr>
<td>Late</td>
<td>Physiotherapy</td>
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<td></td>
<td>Physiotherapy</td>
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Top tips

- Meticulous haemostasis.
- Traction and counter-traction.
- Dissection on a broad front.
- Beware of anatomical variations.
- If you get stuck, start dissecting elsewhere and come back.
- Position patient head down at completion to raise venous pressure and identify bleeding points.

References

2. Crile GW. Excision of cancer of the head and neck. With special reference to the plan of dissection based on one and hundred and thirty two operations. JAMA. 1906; 47: 1780–1786.

Suggested readings
