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General Inspection and Initial Stages of Evisceration

Before using any instruments, it is vital to remember several important points, reiterated here to emphasise their importance. First, and most important, if consent is required it must be available for the prosecutor to inspect and it must be checked. It is crucial to determine what has been consented for and what has been excluded. This includes routine parts of the examination or limitations, special techniques, tissue retention, and histology. It is likely to become important in the future to check whether it is possible to use for teaching purposes or, especially, research, any tissue that had been removed. Second, it is always vital to verify the patient's identity [in hospital cases the name-band(s) should be checked; in other cases the relatives or a legal representative should identify the body formally]. This may be the coroner, a coroner's officer, or a representative of the police. Rarely it may be necessary to employ forensic dental examination practices or other means to try to identify an unidentified body.

All relevant information should be freely available and consulted, including a written clinical history and any results from investigations that have been undertaken (see Table 2.1). This includes radiographs and previous pathology reports. One should never feel pressured into starting a post mortem examination without reviewing all of the appropriate information and necessary reports. Recent pathology specimens may require review, especially if they are thought to have any relevance to the subsequent post mortem examination. It is useful to utilise a standard pro-forma request form for hospital post mortems indicating the reasons for the examination and specific questions to be answered, relevant medical history, and results of the significant investigations. The prosecutor should be dressed suitably for the nature of the examination and the appropriate instruments should be clean and in satisfactory order (as outlined in the previous chapter).

In summary, prior to the examination:

- Check consent forms.
- Check the identity of the body.

TABLE 2.1. “Minimum Dataset” for Information Presented for Deaths in the Community

Identifying information
Place and time of death
The precise circumstances of death
The medical history and prescribed medications
Recent hospital admissions with details of location and lead clinician
Known or suspected use of alcohol or other recreational drugs
Occupation
Phone number of the patient’s general practitioner

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- Read all available notes and information.
- Determine questions being asked.
- Identify any special techniques required.
- Assess risk.

General External Inspection

It is good routine practice for the mortuary staff to record the height and weight of the cadaver, and these measurements should be made available to the prosecutor and included in the subsequent report. As the cadaver is approached on the dissecting table, the prosecutor should begin to note the external appearance, paying particular attention to the ethnicity, gender, build, state of cleanliness, skin colour, and the presence of any distinguishing features such as scars, tattoos, or malformations/deformities (Fig. 2.1). In common with the initial clinical examination of any living patient, the examiner should make a note of any cachexia, which may give a clue to an underlying malignant neoplasm; pallor, raising the possibility of anemia; redness, which could indicate carbon monoxide intoxication or suffocation; jaundice, in cases of biliary obstruction, liver parenchymal disease, or haemolysis; cyanosis; clubbing, which could suggest internal neoplasm, lung disease, inflammatory bowel disease, among others; or lymphadenopathy (reactive or neoplastic). A careful inspection of the nails and skin is then made and the abdomen palpated to identify ascites or any intraabdominal masses or organomegaly such as an enlarged spleen or liver resulting from an infective, reactive, or neoplastic process. This may more difficult than in life but in most cases any such findings are frequently recorded in the notes. Even if these have already been documented, they should be reaffirmed at post mortem. In females palpation of the breasts is essential to avoid missing any palpable lesions (These will also be sliced at a later stage of the examination.). In males the testes could be palpated but are usually examined after removal. Any findings can quickly be noted prior to “gloving



FIGURE 2.1. External examination begins as the body is approached on the dissecting table. (Courtesy of Mr. Dean Jansen, Whittington Hospital.)

up” or by a clean assistant on a printed sheet that contains a diagrammatic plan of the anterior and posterior aspects of a human body. This also acts as a memory aid when one completes the post mortem report after the examination and is used for recording organ weights (Fig. 2.2).

It is easy to neglect the anogenital area from the external examination because significant pathology is rarely situated here but this region should be examined, particularly in forensic cases, so that unexpected findings are not missed. All drains and intravascular access lines should be left in situ in order that their position within the body can be determined, with microbiological samples taken if appropriate. These should also be documented on the body plan. Other external features to be specifically examined include the presence of rigor mortis or peripheral oedema. Again, as with any clinical examination, the latter should be depressed in order to detect if the oedema is pitting and therefore likely to be hypostatic in origin. Non-pitting oedema is more usually a feature of lymphatic obstruction. Rigor mortis is caused by muscle hardening resulting from metabolic changes in myoproteins. Many factors can have an effect on the time course of this stiffening, making its use as a means of accurately establishing the time since death fairly redundant. However, a rough guide for most cases is that rigor mortis commences within 6 hours of death; it takes 6 hours to become

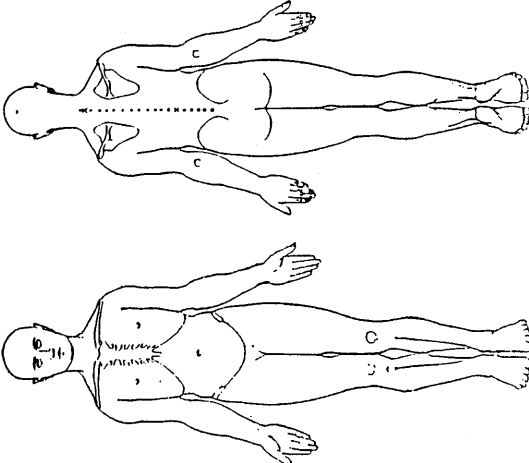
NAME OF DECEASED : AGE :		P.M. NUMBER : DATE :			
SCARS : TATTOOS : BED SORES : ETC.		BRAIN : HEART : LIVER : SPLEEN : L.LUNG : L.KID : R.LUNG : R.KID :			
HEIGHT : WEIGHT :		INTERNAL			
		EXTERNAL			
		SKIN : PALLOR JAUNDICED PINK (CO) CYANOSIS		WELL / POORLY NOURISHED.	
		EYES : ARCUS SENILIS JAUNDICED HAEMORRHAGIC		PERIPHERAL CENTRAL	
		INTERNAL		STERNUM	
		CHEST : ADHESIONS		LEFT LEFT DENSE SCATTERED	
EFFUSIONS		RIGHT : LARGE MODERATE SMALL		LEFT : LARGE MODERATE SMALL	
PLEURAL PLAQUES HIATUS HERNIA PERICARDIUM LAD		CIRC.		HAEMOPERICARDIUM R.C.A	
ABDOMEN : ADHESIONS		DENSE SCATTERED		CLEAR ASCITIC PURULENT FAECULENT BLOOD STAINED	
EFFUSIONS		LARGE MODERATE SMALL		RETROPERITONEAL HAEMORRHAGE	
PERFORATION - SITE OBSTRUCTION - CAUSE DIVERTICULAR DISEASE		RETROPERITONEAL HAEMORRHAGE			

FIGURE 2.2. Proforma for the noting of external appearances of the body prior to external examination together with a chart for internal findings and organ weights. (Reprinted with permission from Drs. S. Hill and A. O'Reilly, St. Alban's and Hemel Hempstead NHS Trust, Hemel Hempstead, UK.)

fully established and it remains for 12 hours before fading off over another 12 hours.

Skin

The general appearance of the skin is noted, bearing in mind that hypostasis and post mortem lividity may significantly alter its appearance and give a misleading impression of underlying pathology. Other aspects of the skin such as colour, pallor, jaundice, needle marks, bruising (which may be perfectly innocent from intravenous line insertion but may be associated with anticoagulant use, haematological disorders, drug abuse, or liver disease), rashes (Fig. 2.3), blisters, or ulceration should all be recorded. It is also wise to consider performing a skin biopsy for any undiagnosed lesion but such biopsy specimens should, if possible, be taken from an area that will not be obvious to distraught relatives when viewing the body subsequently and thereby aggravate their grief. Occasionally reflective ultraviolet photography may be useful in demonstrating faint marks or bruises not readily visible in normal light.



FIGURE 2.3. The skin should be inspected for many conditions, including rashes. (Courtesy of Mr. Dean Jansen, Whittington Hospital.)

Trauma

In deaths associated with trauma it is essential to document all injuries, particularly those involving the soft tissues and bones. These should all be recorded on the body plan diagrams described earlier, with measurements and descriptions documented. Fractures are often obvious externally and usually can be confirmed by palpating and moving the area concerned. Some soft tissue dissection around a wound site may be appropriate to confirm the presence and extent of a fracture. Rarely it may be necessary to obtain radiographs to identify or confirm a fracture and this will also allow photographic documentary evidence of such pathology. These radiographs may have to be performed in the radiology department, however, and this obviously may produce logistical and potentially hazardous problems. In cases involving multiple injuries, such as road traffic accidents, the fractures are frequently documented in the accident and emergency department prior to death, before transfer of the patient to the mortuary. In some instances, such as cervical spine fractures, it may be useful to wait until the organs have been eviscerated before the anterior aspect of the upper vertebral column can be directly visualised and assessed clearly. When a fracture at this site is likely, or indeed possible, *an alternative approach is to inspect this region by dissecting the soft tissues of the posterior neck with the cadaver lying in a prone position on the post mortem table. This should prevent confusion caused by any apparent pathology or defect present as a result of overzealous dissection of the tissues of the antecervical vertebral area when “dropping the tongue” (see later).* This and other methods for examining the cervical vertebrae are described in Chapter 11.

Wounds

Wounds also require accurate documentation, again with diagrammatic records. Occasionally it may be necessary to identify an infective organism associated with a surgical or traumatic wound. If this is required the first step is to clean the overlying and surrounding skin with alcohol, open up the wound by separating the edges, and introduce the tip of the swab into the defect formed. The swab can either be sent directly to the microbiology laboratory in the appropriate medium or container, or, alternatively, smear preparations can be made and stained in the histology/cytology laboratory. Clearly both can be performed, and as with any investigation it is always worth considering sending two samples to confirm the results.

Hair and Eyes

Elementary characteristics such as hair quantity and colour are often overlooked in the external examination, but occasionally such simple observations may give an important clue in helping to identify an unidentified

corpse. Similar comments can be made regarding noting the presence of a wig. Toxicological analysis of hair may also be a useful means of documenting substance abuse or poisoning (see later). The eyes should always be inspected. Again, as in the routine clinical examination, the presence of jaundice, xanthelasma, Keiser–Fleischer rings, and arcus senilis may all indicate which internal organs need to be assessed in particular detail. Thyroid-related eye disease may be apparent and of course glass eyes should be documented in order to save possible embarrassment at a later date.

Mouth

It is essential to inspect the mouth carefully and make a note of the presence of dentures. Other features that may be seen in and around the mouth include endotracheal tubes, any emissions, mass lesions, and evidence of trauma such as frenulum rupture. The latter may be an indicator of nonaccidental injury in children (and also sometimes in adults). The other external passages such as nose, ears, and genitalia also need close inspection, particularly in the setting of a perinatal post mortem. In this case their patency should be assessed by gentle probing of the orifice. In adults, identifying blood or masses emanating from one of the external orifices can sometimes be informative.

As discussed earlier, any significant features can be recorded on a preprinted plan of the body, but photographic records or video recording may also be appropriate in certain situations and may be very useful when the clinicians cannot be present at the demonstration. In these circumstances, however, one should always refer to the consent and verify that permission has been given. Another situation in which this simple method of documentation may be useful is in the training and teaching of students and postgraduate trainees. Even in this setting there is a requirement to confirm that consent has been granted.

Preparatory Stages of Evisceration

Evisceration takes place in two stages, with a preparation stage preceding organ removal. Preparation includes the preliminary skin incisions and thoracic and abdominal wall dissections to expose the internal organs. It also involves removal of the sternum in order to gain access to the thoracic cavity to be able to examine the internal contents. We have chosen to include here the technique for dissecting the neck and releasing the neck structures, as this is common to all of the subsequent methods of evisceration. At the completion of this stage, organ removal can proceed via any one of several well-recognised methods described in Chapter 3.

The four most widely used techniques are described here, and although individual laboratories and practitioners may have their own techniques, these usually vary only slightly from one of these four major protocols. It

is noteworthy that different methods are followed in different countries, with local preference dictating the technique that is passed on to the trainees passing through a particular department. Depending on the clinical situation and personal preference, the method followed may vary—removal of either individual organs or groups of organs (organ blocks), removal of organs en masse, or dissection in situ; the relative pros and cons of each method are discussed later in this chapter. Whichever method of evisceration is preferred, the general preparation stage follows a similar routine.

Having first established a comprehensive external examination, one needs to deal with any significant findings noted during that part of the examination (such as a wound, cannula, or drain site) before the internal examination proper begins. At this stage it is also necessary to identify fistula sites if present so that they are not destroyed or distorted during organ evisceration. The course of the latter may be demonstrated by the injection of Indian ink through the external porthole and tracing the route of the dye's movement. *Alternatively, barium sulphate contrast medium can be introduced using a syringe via the same orifice and subsequent X-ray films taken.* As stated in the previous section, drains and cannulae should not be removed before their exact internal position is established, as occasionally this may have a direct bearing on the ultimate cause of death. For example, cases have been recorded in which accidental penetration of the wall of the superior vena cava has occurred during central venous line insertion, with catastrophic and fatal hemorrhagic results.

Several other less common situations may arise that need to be investigated early in the examination so that their presence is not overlooked. In certain instances, if the particular condition is not searched for and recorded specifically at the outset then it may well be impossible to reconstruct the tissue at a later stage of the examination to confirm or refute its presence. Two good examples of such situations include pneumothorax and air embolus. These obviously are very uncommon but still need to be considered in *every* case, prior to any substantial cutting. The possibility of such pathology needs to be specifically sought and excluded. An examination for a pneumothorax should be part of all post mortems, as a matter of routine; it is described in detail in the following section. Formal investigation for an air embolus applies to a more restricted number of cases and is therefore described briefly later and repeated in the section on maternal deaths in Chapter 8.

Collection of Samples

Collection of blood and/or other tissue or fluid specimens for microbiology, toxicology, or biochemistry assessment should be performed as early as possible during the examination to keep contamination to a minimum. Samples should be transported to the appropriate laboratory with all relevant paper-

work adequately completed as soon as possible after death. In many cases this may be necessary before dissection begins. For microbiology, nasopharyngeal swabs, wound swabs, urine, or blood can be taken before the examination proper proceeds, sometimes a day earlier. It may be useful on occasion to wait for the results of such tests before deciding on any extraordinary techniques that may be required during the examination. It may also be helpful to await specific serological results, such as those that indicate human immunodeficiency virus (HIV)-positive status, because these may actually preclude a post mortem examination (at least in a routine mortuary unequipped for high-risk cases), in which situation the body should be transferred to an appropriate centre. Fluids may also be sampled for chemical or toxicological analysis prior to dissection but it should be remembered that cardiac blood may produce problems with interpretation owing to diffusion, particularly with alcohol. This usually arises if there is a delay before the examination takes place.

The following are samples that may be required at post mortem:

- Blood
- Urine
- Hair
- Vitreous humour
- Gastric contents
- Bile
- Cerebrospinal fluid
- Samples of tissue

Blood

Blood can be sampled from the heart by performing a cardiac puncture with a syringe and long sterile needle, or more usually from a large femoral vessel, subclavian vessel, or, less optimally, a jugular vein. The last two peripheral vascular sites should be readily accessible and fairly easy to cannulate. Cardiac blood is rather more difficult and requires blind puncturing and aspiration through the anterior chest wall if performed before evisceration. A technique similar to that used for pericardial paracentesis can be employed by passing the needle through the fifth or sixth intercostal space anteriorly and applying gentle suction on the syringe plunger. It is difficult to contemplate when this awkward procedure for sampling blood may actually be required, but it is included here for completeness. Once the chest has been opened the situation is simplified and the heart can be visualised directly.

If blood is required for microbiological analysis it is preferable to take the sample before the examination if possible, using a sterile syringe and needle. The blood is collected into the appropriate blood culture bottles and transported in these to the microbiology department. Blood samples for

toxicology, including drugs and alcohol, should also be taken early to avoid contamination later on in the examination. It should be remembered that right atrial blood may overestimate glucose concentration because of glycogenolysis in the liver, and that samples taken for alcohol estimations may need to be collected into appropriate tubes containing antibiotic (to prevent fungal and bacterial growth) to prevent false high values. Further details of the appropriateness of blood sampling are given in Chapter 13.

Urine

Urine can be obtained in a variety of ways, either before the dissection begins or after the abdomen is opened. In the first instance urine can be collected in a suitable sterile or nonsterile “universal” container for either microbiological or toxicological analysis by catheterising the urethra and bladder and draining off the bladder contents. *An alternative is to puncture the anterior abdominal wall directly, above the pubic prominence, and withdraw urine into a syringe via a sterile needle.* It is obvious that this latter method may also be performed using the same equipment once the abdomen has been opened and the bladder punctured under direct visualisation. Once the abdomen is open the dome of the bladder can be opened using forceps and scissors or a scalpel while the lower abdominal contents are held away by an assistant. A syringe is inserted through the opening in the bladder wall and urine removed and collected into a suitable container.

Cerebrospinal Fluid

There are three acceptable methods for collecting cerebrospinal fluid (CSF), either by performing a routine lumbar puncture on the intact body before the examination—which will clearly require considerable assistance—or by withdrawing fluid using a needle and syringe from the central cistern or lateral ventricles, the latter after the skull has been removed. CSF aspiration from the central cistern involves passing the needle through the atlanto-occipital membrane, just below the occiput, into the cistern. Of course, CSF can be removed from the foramen magnum once the brain has been removed, but this will inevitably be contaminated with blood and possibly other fluids, so the results should be interpreted with caution.

Vitreous Humour

Vitreous humour can be aspirated by puncturing the sclera with a sterile needle attached to a syringe. This is introduced laterally and volumes up to 2 to 5 ml can be removed in this way. The needle should be left in situ while the syringe is removed, the fluid collected into a container, and the syringe reconnected once filled with saline to replace the aspirated fluid. It has been shown that concentrations of electrolytes such as sodium and chloride

may be measured fairly reliably in this fluid for some time after death and that glucose concentration is approximately half that in the peripheral blood. Toxicological analysis of vitreous humour may also sometimes be possible, although with all measurements the results need to be assessed in context and the time since death may have a significant effect on the values.

Stomach Contents

Gastric contents may occasionally be required for toxicological analysis, and although sampling will obviously be possible only after the peritoneum has been opened, it is discussed here with the other sampling techniques. When analysis is required the easiest way to collect the contents is to lay the unopened stomach over the edge of the dissecting board and make an incision along the greater curve, catching the contents as they spill from the gastric lumen. *Alternatively, the stomach can be opened at any site and the container introduced through the incision to collect at least some of the contents.* If it is particularly important that an accurate estimate is required of some constituent of the contents then it may be best to tie off the cardiac and pyloric ends of the stomach, transect the duodenum and oesophagus, and send the whole specimen intact with contents in situ. A similar method may be used for retaining intestinal contents. This involves tying off a short (approximately 15 cm) segment of small or large bowel, separating it from the rest of the tract, and sending it for analysis.

Bile

Bile may be analysed for levels of drugs, particularly those excreted through the biliary system. Bile is obtained by passing a needle, attached to a syringe, into the lumen through the wall. Bile is aspirated and collected into a container prior to transport to the laboratory. *Alternatively, bile can be collected once the gallbladder has been removed during evisceration and bile expressed through the cystic duct or collected when the body wall is incised.* There is obviously more scope for loss of sample this way, however, and needle sampling is preferred.

Hair

Samples of hair can be used to determine previous exposure to a variety of substances. This is most commonly required in cases of drug toxicity or poisoning if other samples such as blood or urine are not available (perhaps because of decomposition) or when determination of longer term low-quantity exposure is suspected. In such circumstances the presence of the substance can be confirmed and levels correlated with chronicity or toxicity.

Hair is usually sampled from the head, although hair obtained from other areas is also acceptable. It is useful and frequently necessary to include the root of the hair, and so it is better to pluck the hair rather than cut it. (This may be different for forensic examination in which cut hair is examined for substances attached to the hair.) The hair is often transported to the laboratory in foil. Analysis can determine the drugs levels, and the period of use can be established when correlated with the position of the sample along the hair.

Microbiology

If microbiological examination is warranted then swabs may be used as a method of fluid/contents sampling at any of the preceding sites (meninges, intestines, and bladder). These are taken by introducing the tip of the swab into the area of interest and rapidly closing the swab stick in the holder after the swab has been inserted. If superficial wounds are present or swabs need to be taken from mucocutaneous orifices, the edges should be avoided and the swab introduced deep into the cavity after the local adjacent area is cleaned before swabbing. A similar technique can be used for producing microbiological samples from solid tissues such as the spleen. The surface of the organ should be seared using a flat-faced soldering iron or scalpel blade. The latter is heated in a flame (a Bunsen burner can be quite useful) before using. A sterile blade is then used to incise the tissue and the swab is inserted as the edges are held apart briefly. Again the swab is replaced into its sheath. With solid organs such as the kidney, spleen, or liver a portion of tissue can be removed using the same searing method and a sterile scalpel, the tissue being about the size of a small die (a cube with 1-cm sides).

Preliminary Skin Incisions

As mentioned earlier, the preparation stage of evisceration follows a relatively standard approach irrespective of the subsequent manner of organ removal. The general principles are to cut into and reflect the skin and subcutaneous soft tissue to expose the deeper tissues. In the thorax this obviously includes removing part of the thoracic cage to allow access to the internal structures. Before any incisions are made, the top of the back should be supported from underneath by a block that is positioned between the scapulae so that the neck is extended. In doing so the following skin incisions are made easier.

Anterior Body Wall Incisions

Many initial skin incisions are used in preparation (see Fig. 2.4a–d), but the most commonly used all follow similar routes with the first incision made

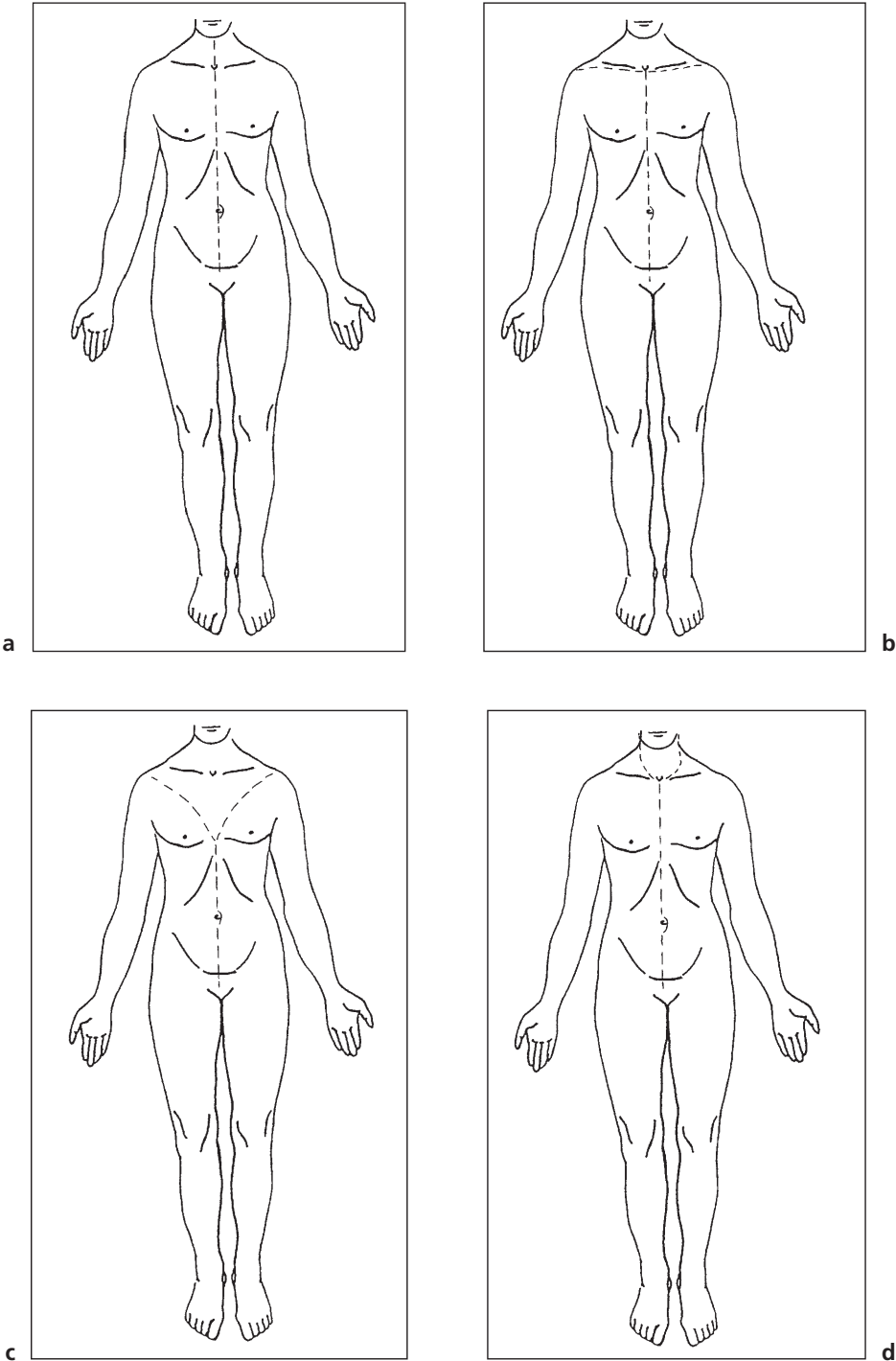


FIGURE 2.4. Skin incisions.

from the suprasternal notch inferiorly along the sternum, extending further inferiorly along the anterior abdominal wall to the pubis. Most prosectors use the PM40 for these incisions. The upper part of this incision requires substantial pressure in cutting down to the bone, but movements in the lower portion should be gentler, with care not to damage the underlying abdominal organs. The lower portion should travel down the midline, skirting just lateral to the umbilicus to end at the symphysis pubis. One should be particularly careful with the abdominal wall incision if the presence of free gas within the peritoneal cavity is suspected. This clearly needs to be confirmed or excluded before the peritoneal cavity is opened and any gas escapes unnoticed.

If intraperitoneal gas is likely to be present such as with a gastrointestinal tract perforation, a small pocket should be made in the extraperitoneal soft tissue of the anterior abdominal wall which is then filled with water. The peritoneum is punctured through the water and any gas should be demonstrated as bubbles within the water. Free abdominal gas is obviously extremely rare, and in most routine cases formal testing for this is not required. If this is not necessary, the peritoneum can now be nicked through with the scalpel and two or three fingers inserted into the abdomen. The abdominal wall skin and subcutaneous soft tissue is then lifted with this hand while a large bladed knife (PM40) or scalpel is used to make longitudinal cuts down to the pubis (some like to cut carefully between the fingers held apart). These large abdominal flaps of skin and underlying musculoadipose tissue can be loosened by slicing through the everted muscle coats but being careful not to cut too deeply and puncture the adjacent skin. With all incisions, it is wise to avoid (particularly) recent surgical scars so that they can be inspected carefully before they are damaged beyond recognition.

Alternatively, a Y-shaped incision is made with the straight line of the Y corresponding to the xiphisternum-to-pubis incision described earlier, and the forks of the Y running superiorly across the chest, skirting the breast tissue medially and extending toward the lateral ends of the clavicles and acromium processes.

At this stage the peritoneum can be inspected and a careful note of any masses made. All fluid should be collected whether it be ascites (associated with visceral tumours, congestive cardiac failure, or portal hypertension), peritoneal pus (indicating intraabdominal infection and/or perforation), or blood (following a ruptured vessel such as an atheromatous aneurysmal aorta). Any relevant tissue or material is removed from the peritoneum and dealt with accordingly. Any blood present is collected and its volume measured. Pus should be collected in a sterile container using either a sterile syringe or syringe and needle. *An alternative is to swab the infected peritoneal fluid or surface and transfer to the microbiology department in the sealed swab holder.* Obviously only the superficial structures are easy to inspect, but inspecting and palpating the organs may reveal a mass. Usually,

as the anterior organs are removed the deeper ones become visible and these can be inspected and palpated.

Neck Incisions

The incision is continued superiorly in one of at least three ways. The first is a straight incision in front of the trachea. The second is bilateral extension of the primary incision along the anterior border of the clavicles to the skin in front of the acromium process. The third is also a bilateral incision, extending the primary incision again along the anterior border of the clavicles but moving superiorly toward the tragus along the lateral side of the neck, ending just behind the ears. If air embolus is a possibility the neck dissection should be performed particularly carefully, being alert not to injure the large neck veins. The skin and superficial subcutaneous tissues of the neck are now reflected upwards to expose the underlying structures. A useful safe and controlled method is to grasp and retract the cut border of the skin using one's fingers or nontoothed forceps and make horizontal sweeping slices with a small scalpel along the dermosubcutaneous tissue junction/plane. The latter cuts should be extremely gentle and made with limited pressure with the blade angled away from the skin surface so that penetration of the skin should not occur. Be extremely careful not to make any "buttonholes." Whichever method is chosen the soft tissue of the anterior neck should now be exposed.

Face

Rarely it may be necessary to extend the superficial subcutaneous dissection superiorly, to display the underlying facial soft tissue and/or bone. This may be required when dealing with forensic type cases that involve facial damage caused by traumatic injury, or in the case of parotid gland disease. Particular care, with extreme patience, needs to be taken in pursuing the plane between dermal and subcutaneous tissue. Patient dissection should enable precision in order that the overlying skin is not punctured (the latter is impossible to satisfactorily reconstruct invisibly). Directing the scalpel blade away from the epidermal surface at all times helps to prevent such "buttonholes."

Demonstration of a Pneumothorax

The skin and subcutaneous tissues are then reflected from the chest wall, being careful not to open the pleural cavity. This is done by sweeping cuts with a PM40 through the subcutaneous tissue over the chest wall, angling the blade down toward the bone of the ribs. Be careful not to puncture the intercostal soft tissue and penetrate the pleural space, as this releases air from an underlying pneumothorax and makes subsequent demonstration

impossible. When this is completed, by reflecting to the mid-axillary line, water is poured into the angle between subcutaneous tissue and the chest wall, and the intercostal tissues below the water line are pierced with a blade. This should establish whether there is an underlying pneumothorax, which may occur following trauma (a tension pneumothorax) or in patients with chronic obstructive airway disease or asthma. If present, bubbles of air will be seen rising through the water. If this sealed procedure is not followed, a pneumothorax can easily be overlooked.

An alternative method is possible but it should be performed before any incisions are made. This involves introducing a wide-bore needle attached to a 50-ml syringe into the subcutaneous tissue over an intercostal space. The plunger should be removed previously and the syringe then filled with water. The needle is pushed slightly deeper to enter the pleural space and the water watched for the presence of any bubbles. The latter is evidence of a pneumothorax. A similar procedure is then followed on the other side. A third alternative involves post mortem chest X-ray film and assessment in a manner similar to detection of a pneumothorax in a living patient. A radiological opinion might be helpful in this case.

Air Embolus

When the possibility of a venous air embolus exists it may be worth considering obtaining a plane chest X-ray film before eviscerating in an attempt to demonstrate the pathology. The retinæ should also be examined thoroughly, looking for intravascular bubbles with an ophthalmoscope (this requires corneal moistening with isotonic saline to prevent interference from corneal opaqueness). During dissection of the neck the large neck veins should be carefully exposed but not opened. It is crucial that the large neck veins are left intact before the heart is dissected in situ to avoid the confusion of air being introduced during evisceration. The abdomen is opened in the usual manner, and the abdominal contents are moved gently out of the way to inspect the inferior vena cava closely for bubbles in the lumen through its transparent wall.

The sternum is then removed by dividing the ribs, being careful not to puncture the pericardial sac. The medial dissection should be through the sternum distal to the sternoclavicular joint. The internal mammary vessels should be clamped. *An alternative is to cut a small hole in the sternum and leave the ribs intact.* The anterior pericardial sac is then opened and the external epicardial veins inspected for evidence of intraluminal bubbles. Water is then introduced into the pericardial space to fill it. Once completely covered in water, the right atrium and ventricle are incised and careful inspection is made to identify any air bubbles that escape. *Alternatively, a water-filled syringe (minus plunger) is connected to a needle, which is inserted into the right ventricle, and the syringe chamber inspected closely for the presence of bubbles.*

When the presence of an air embolus is established the vena cavae should be clamped and the thoracic and abdominal cavities flooded with water in an attempt to localise the source of the embolism if at all possible. Sometimes intracardiac gas produced by post mortem bacterial activity may produce a false air embolus appearance. To prevent error, cardiac blood and pericardial fluid should be sent for microbiological examination at the same time. *A quick alternative is to perform a pyrogallol test (Ludwig 1979). For this a 2% pyrogallol solution is freshly prepared and approximately 4 ml collected into two 10-ml syringes. Four drops of sodium hydroxide (0.5 M) are introduced into the first syringe and the mixture should turn yellow. Gas is then aspirated from the right side of the heart and the needle removed and replaced with a stopper. The syringe is then shaken and the mixture should turn brown if air is present. In the absence of air the solution stays clear (indicating gas production by bacteria). The second syringe is used as a positive control by following the same procedure as earlier but including a volume of air at the same time as the sodium hydroxide is introduced. This should obviously also turn brown. The second syringe can also be used as a repeat test should the first prove unsatisfactory.*

Arterial air emboli are even more unusual and usually result from traumatic injury such as thoracic trauma involving the pulmonary veins or following air introduction during cardiopulmonary bypass. A much smaller volume of air is associated with such emboli and accordingly these are much more difficult to demonstrate. Systemic emboli may be verified by inspecting the intracranial vessels of the meninges and circle of Willis and then examining under water after clamping the internal carotid and basilar arteries if necessary.

Chest Wall Dissection

Once the soft tissue has been reflected from the chest wall the breast tissue should be palpated and sliced longitudinally from the deep/internal aspect to expose any masses present. If present, several blocks of the lesion should be taken for subsequent histological assessment. Axillary lymph nodes should also be sampled in such circumstances. After this the intercostal muscles are cut so that the underlying lung can be pushed away from the parietal pleura. Superficial gentle cuts are made and if there are no pleural adhesions the lungs should lie posteriorly within the thoracic cavity as a result of gravitational effects, and slicing through the intercostal muscles should not cause any inadvertent damage to the underlying lung parenchyma.

Any loose adhesions that are present can usually be detached quite easily by blunt dissection using fingers pushed through the intercostal spaces produced after cutting through the muscles. Densely adherent fibrous bands may indicate old infection such as tuberculosis, chronic lung disease, or a pleural or underlying lung tumour. In such cases it is much more difficult

to detach firm adhesions. The principal idea in this situation is to try to find the plane between the inner aspect of the chest wall and the lining parietal pleura. This is usually possible but it may take a little time to identify the correct plane. Once this is found, by firm blunt dissection, or a limited amount of knife cutting, the parietal pleura can be worked away from the chest wall and left attached to the underlying lung. Most of the tissue can be detached in this way but it may be necessary to deal with some of the remaining tissue at a later stage when the sternum has been removed.

The next step involves reflecting the sternocleidomastoid muscles superolaterally from their inferior sternal and clavicular attachments in order to expose the large veins of the neck. It should always be remembered, however, that if the craniocervical junction is a particular area of interest, for example, in patients with rheumatoid disease or when this area needs to be removed completely for vertebral artery examination, the sternocleidomastoid muscles should be left attached to their insertions [1]. If they are not, then there will be virtually or absolutely no anchoring tissues for the head and this will become completely detached—a rather distressing situation for both pathologist and technician waiting to reconstruct the body prior to viewing by the relatives.

Removing the Sternum

Using the rib cutters and beginning inferiorly, the costal cartilages are cut by sliding the lower blade of the shears beneath the cartilage close to its bony attachment to the rib and shearing through the firm tissue as cleanly as possible (in younger cadavers the cartilage is usually soft enough to cut through with a knife). Try to cut the cartilage just medial to the rib rather than the bone in to avoid exposing sharp edges. *Alternatively, the sternum can be removed by cutting through the same regions but from the second rib inferiorly to the lower costal margin.* In older cadavers the costal cartilages may be extensively calcified, making this impossible, but in this case safety can be optimised by putting a towel or the reflected skin over the potentially hazardous edges (Fig. 2.5). The sternum can now be released by grasping the lower end and lifting the sternum as horizontal cuts are made upwards toward the deep surface of the sternum to detach the adjacent anterior mediastinal soft tissue. It is important to slant the blade and direct it toward the underside of the sternum so that soft tissues such as the pericardium are not damaged. If the latter were to occur then the pericardial fluid contents may be released and lost into the pleural cavity. Knife cuts may also be necessary through the strands of tissue still attached around the costocartilagenous areas previously divided.

Using a large blade, cuts are then made through the sternoclavicular joints and the clavicles reflected. To do this the lower border of the clavicle can be traced toward the manubrial sternal edges using the PM40 and the angle between clavicle, rib, and manubrium divided. Gentle manipula-



FIGURE 2.5. Protection from cut ends of ribs by skin.

tion of the lateral part of the clavicle may aid in locating the exact site of the joint. The knife is inserted into the joint and a rotary cut is made together with peripheral manipulation and a series of up-and-down strokes through the joint to disarticulate the clavicle from the sternum. The underlying vessels are inspected before the first rib is cut about 1 cm lateral to the cut made through the second rib/cartilage. Occasionally this joint can be heavily calcified and the rib shears can be utilised again.

Although this procedure often requires considerable force it should be remembered that large vascular structures lie just beneath this area and so the cuts made here should not be too deep, as these vessels can be damaged easily. In this way the large vessels situated just beneath the joints should be protected from extensive inadvertent damage caused by blind cutting which causes blood to mingle with pleural contents. The sternum can now be lifted off. It is now put to one side, as it will almost certainly not provide any useful information relevant to the remainder of the examination.

Mediastinal and Pleural Inspection

The thymus may be visible at this time, particularly in younger bodies or in the presence of thymic pathology. In addition, the presence of mediastinal disease such as mediastinitis or mediastinal emphysema can be established. Once the thoracic cavities are exposed access can be gained to the pleural spaces, and any pleural fluid can be collected using a ladle and quantified

in a measuring jug. Fluid can also be collected at this stage for protein content measurement, cytological analysis, or any other type of investigation which may be required subsequently. Other material such as blood or pus can also be collected for subsequent quantitative or qualitative analysis.

Freeing the Oral and Neck Structures

After the mouth is inspected thoroughly, any loose contents or dentures are removed manually. The tongue is then “brought down” by making an incision around the internal surface of the mandible from below, being careful not to cut through the salivary glands or tongue, which should be inspected at this point to check that no significant pathological lesions are present.

To perform this part of the dissection safely, a hole is first produced by the point of the blade through the muscular tissue in the midline just behind the midline symphysis of the lower jaw. The attached suprahyoid, lingual, and other muscles will thereby be divided. A finger or fingers can then be pushed through this hole behind the inner surface of the mandible and the tongue grasped and pulled through this gap. The scalpel is placed back through this same gap and the soft tissue dissected away from the posterior aspect of the internal rami of the mandible, sweeping laterally and dividing the glossal muscles as one continues back to the posterior pharynx. The parotid and submandibular glands should be examined as this dissection takes place.

The hole should now be large enough to allow the whole tongue to be pulled inferiorly through it and the stylohyoid ligaments divided. While the tongue is held further down and pulled firmly with the free hand the upper parts of the styloglossus are freed and a series of firm horizontal incisions made through the soft palate and posterior pharynx (including the tonsils) down to the fascia covering the anterior surface of the cervical vertebrae.

The first of these horizontal cuts should be made as high as possible above the uvula and oropharynx so that the carotid arteries are removed with this section of tissue. It is important to remove the carotid bifurcation in order to inspect the area and identify any atheroma, thrombus, or other significant pathology at this site. The pharynx is closely inspected at this time and any masses noted. Swabs are collected at this stage if infection is suspected and if they have not already been taken.

Detailed Examination of the Neck

There are certain situations, such as infarcts in the posterior intracranial fossa or forensic cases dealing with neck compression or traumatic injury, in which a more careful and detailed examination of the neck structures is

essential [2]. The method of dissection varies only slightly from the method described earlier and will be directed by the type of suspected injury or disease. If compression injury is suspected care needs to be taken with dissection of the anterior structures; in traumatic spinal damage the posterior compartment is of more interest.

Anterior Structures

After careful external examination of the neck and removal of the brain to allow drainage of blood from the head in order to avoid artefactual haemorrhage, attention turns to the anterior neck dissection. In fact, some advocate going further than this and suggest dividing the superior vena cava and trachea, and removing the chest organs prior to neck dissection. For the latter a bilateral, curved neck incision is recommended (as described earlier) and care is taken to avoid injuring the neck veins during dissection of the subcutaneous tissue. This tissue and the adjacent platysma muscle are inspected for evidence of bruising at this stage. The sternocleidomastoid muscles are left intact at this point and the external jugular veins examined.

Once the integrity of the external jugular veins is established, the underlying muscles are reflected in layers. First the sternal head of the sternocleidomastoid muscles is divided from the manubrium and then the more lateral clavicular head is detached. These are reflected laterally and the suprahyoid and infrahyoid muscle groups are then examined, being careful not to damage any adjacent vessels and produce a false impression of significant haemorrhage. The carotid sheath, including carotid arteries, internal jugular veins, and vagus nerve, is exposed after the omohyoid is reflected. The contained structures are gently mobilised and inspected for evidence of injury and haemorrhage. The carotid bodies can also be inspected at this point.

Further dissection of the anterior neck structures is identical to the routine method described earlier, although extra vigilance is required to identify any evidence of traumatic insult. All of the antevertebral tissues of the neck can now be separated by dividing all of the structures at the thoracic inlet, or further dissection can follow removal of these structures with the thoracic contents (as described in Chapter 3).

Dissection of the Anterior Neck Structures

Once the “strap” muscles are established as free from injury, they are detached from the larynx to expose the thyroid and cricoid cartilages. The larynx is examined from the posterior aspect and the superior cornua identified by incising the pharyngeal mucosa on their posterior surface and

continuing these bilateral incisions longitudinally and inferiorly. Any undisplaced fractures should be carefully identified or excluded.

The hyoid bone itself is inspected by making a tranverse incision across the pharyngeal section of the tongue, continuing laterally through the hypoglossus. This will expose the upper surface of the bone. Once again this is carefully inspected for evidence of fracture. The contents of the carotid sheath are examined by opening the internal jugular veins from their junctions with the subclavian and brachiocephalic veins. Small scissors are used to open the vessels from below. A similar procedure is used to open the common carotids from the aortic arch on the left and the brachiocephalic artery on the right. Inspect the wall and internal surfaces for evidence of tears or thrombi.

Radiography of the Anterior Compartment

A useful method for documenting fractures (especially undisplaced or partial) or airway narrowing is to take radiographs of the anterior compartment contents. X-ray films are taken either in the mortuary or after transfer to the radiology department. This will usually be necessary immediately after excision of the neck structures and before formal dissection of this region begins, although occasionally fractures may be identified during dissection that are not obvious radiologically. Several images should be taken including oblique and anteroposterior views. X-ray films can also be useful in assessing the degree of calcification present in the larynx and therefore the amount of force required for fracture (more calcification implying greater ease in fracturing).

Posterior Structures

The following methods may be essential to document relevant pathology but it should be remembered that reconstruction will be time consuming and will require experience, and thus these procedures should not be undertaken lightly. Removal of the anterior compartment allows the prevertebral fascia to be inspected for evidence of traumatic injury such as the presence of crepitus. The fascia is then reflected from the underlying bone. The body is turned over and the superficial tissues (including the ligamentum nuchae) reflected from the occipital region inferiorly to the base of the neck to expose the underlying soft tissue.

Examination of the Cervical Spine

Several methods can be used for examining the cervical spine, and these are described fully in Chapter 11. The methods for examining the vertebral arteries and for performing vertebral angiography are discussed here.

Examining the Vertebral Arteries

The vertebral arteries can be examined and dissected in one of two principal ways. The first involves removal of the complete cervical spine as described in Chapter 11, followed by decalcification of this block before dissection. For decalcification the excised block is first fixed for 3 to 5 days in formalin, followed by 2 to 5 weeks of immersion in a 10% formic acid/formalin mixture, changing the fluid regularly. When fully decalcified the block of tissue can be serially sliced transversely at 5-mm intervals and the vertebral arteries inspected macroscopically. Any pathological lesion obviously can be sampled for histology.

Alternatively, isolated vertebral arteries can be removed and examined away from the other cervical structures. One of the ways this can be achieved begins by identifying the vertebral arteries as they originate as the first branches of the subclavian arteries. The surrounding soft tissue and the anterior surfaces of the transverse processes are cleared away. The arteries are followed to their point of entry into the foramina in the transverse processes of the sixth cervical vertebrae. Next, the bony bars forming the anterior border of the foramina are cut away with side cutters or small shears and the route of the arteries followed superiorly. As the arteries leave C3 they run laterally to enter the foramina in the axis and then upwards to enter the foramina of the atlas. They now run medially and posteriorly, skirting the upper surface of the posterior arch before once again travelling upwards to pierce the atlanto-occipital membrane. The bone forming the posterior wall of the foramina should be chipped away in order to follow the last part of the vessels' extracranial course. The atlanto-occipital membrane is incised and the path of the vessels is followed into the skull.

Most of the latter can of course also be performed on an excised intact cervical spine block.

Vertebral Angiography

In cases of sudden collapse after head or neck injury, the possibility of subarachnoid haemorrhage following vertebral artery trauma should be entertained. If this is the case then angiography, possibly followed by excision of the cervical spine and skull base, should be considered. The subarachnoid haemorrhage should be evident after the vault of the skull has been removed.

For angiography the vertebral arteries are identified after the subclavian soft tissue has been cleared on either side of the lower cervical spine. The brain is then gently lifted to expose the underlying circle of Willis. The basilar artery is ligated by tying a suture around it (most easily by passing a suture with attached curved needle underneath it) as close to its origin from the junction of the vertebral arteries as possible. The brain is now replaced and the skull vault put back and secured with the scalp skin (a

safety pin may be necessary). The neck is slightly extended and the cervical region is revisited.

The vertebral arteries are divided close to their origins from the subclavian arteries and one of the arteries (usually the larger) is injected with approximately 5 to 10 ml of a warmed mixture containing barium sulphate, gelatin, and gum arabic for elasticity. Injection continues until the white mixture begins to appear at the cut end of the contralateral artery. This is then left to cool before radiographs are taken either in situ or after the cervical block is removed. Once again anteroposterior, lateral, and oblique views should be taken.

At this point the technique varies depending on the evisceration method chosen.

Advantages and Disadvantages of the Different Post Mortem Examination Methods

Before the various evisceration methods are described, it is worthwhile at this point to include a few comments about the general differences between the techniques. It is also important to discuss the relative advantages and disadvantages of each method. It is hoped that in this way the benefits of knowing all of them will become apparent.

En Masse Dissection

The first method to be discussed is the en masse technique, based on a method originally described by Letulle. This involves removing most, if not all, of the internal organs at one time. This method usually requires some help in certain aspects of the procedure and provides a rather bulky mass of organs for subsequent assessment and dissection. Depending on the operator, it may be one of the more rapid techniques for removing the organs from the body although the ensuing dissection is the most lengthy. It has the important advantage of leaving all organ and system attachments intact, allowing relationships between various organs to be adequately assessed. In fact this method is the best of the four for observing the pathological and anatomical relationships between structures. In certain circumstances this method is essential, if the full extent of a pathological process is to be appreciated and realised. For example, the number and sites of vessels involved by a dissecting aortic aneurysm can be fully documented only if all of the central main arteries remain in continuity with the aorta before opening. Demonstration of other pathological processes that occur around or on both sides of the diaphragm will also be best visualised with this method. Letulle's procedure is usually followed for evisceration of organs in perinatal autopsies, as the organ block is obviously not as bulky

in these cases as it is in adult cases. One of the drawbacks with this method is that large external incisions are required and a large conglomerate of organs is produced. Another is that in inexperienced hands this method can be rather time consuming.

The Virchow Method

The Virchow method of evisceration is simply removal of individual organs one by one with subsequent dissection of that isolated organ. This of course is perfectly reasonable in assessing individual organ pathology and is an extremely quick and effective method if the pathological interest is in a single organ. Frequently, however, pathological abnormalities are detected in several organs and in this case relationships will often be difficult to interpret or completely destroyed.

En Bloc Removal

The en bloc method of evisceration is a concession that combines the preceding two methods and is probably the most widely used in the United Kingdom. Ghon developed this method, which is relatively quick but preserves most of the important inter-organ relationships, so that inter-organ relationships and effects such as lung changes caused by cardiac disease and proximal effects of distal urinary tract obstruction can be more readily observed and demonstrated with ease. One of the benefits of this method is that as well as retaining organ relationships, flexibility within the method means that most of the examination can be performed in this standard way. However, if the detected pathology dictates an alternative approach such as cirrhosis (when varices need to be identified and the oesophagus should be transected higher than usual) or an aortic aneurysm (when the extent of vessel involvement needs to be determined and the aorta can be left intact and retained with the cardiothoracic block of tissue), minor deviations from the routine are easily accommodated. One problem with this method, however, is that if unexpected pathology is encountered (again a good example being oesophageal varices related to cirrhosis and portal hypertension) these could be destroyed and thereby neglected by transecting the lower oesophageal region. One can of course modify this method in such cases to preserve oesophageal varices by mixing the methods available. In some circumstances it may be worthwhile to eviscerate most of the organs by means of one method but also including limited aspects of another method for one particular site.

In Situ Dissection

The fourth method, that of Rokitansky, is in our experience rarely performed but is included here briefly for the sake of completeness. This

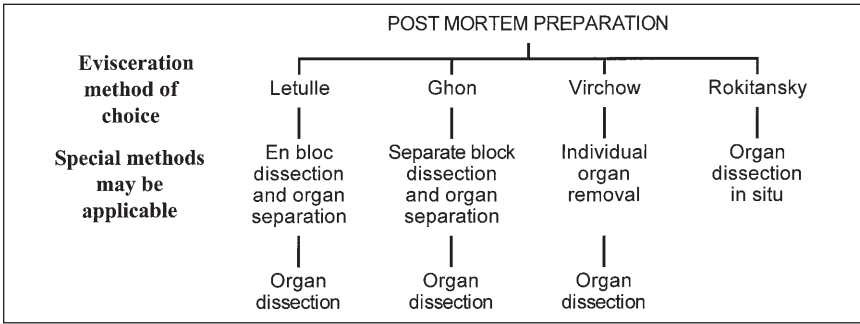


FIGURE 2.6. Schema for differing methods.

method involves dissecting the organs in situ with little actual evisceration being performed prior to dissection. It may, however, rarely be useful especially if speed is of the essence and the information gleaned from the examination is anticipated and accepted to be limited. This may be the method of choice when performing post mortems on patients with highly transmissible diseases so that tissue is not removed from the body. It therefore poses the most limited risk or threat to anyone except the prosector. In the past this method has also been described as particularly useful in post mortem examinations performed in the home!

A schema for different dissection methods is given in Fig. 2.6.

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Further Reading

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