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Intraoperative imaging

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Intraoperative image is a rapidly expanding field encompassing many applications that use a multitude of technologies. Some of the these applications have been in use for many years and are firmly embedded in, and indispensable to, clinical practice (e.g. the use of X-ray to locate foreign bodies during surgery or oocyte retrieval under ultrasound guidance. In others, the application may have been in use in one discipline but not yet fully explored in another. Examples include the use of intraoperative ultrasound with or without contrast enhancement for the detection of hepatic metastases not identified preoperatively, and the effect of such additional information on the ultimate operative procedure. Intraoperative identification of sentinel lymph nodes has been explored in many specialties to a varying extent, with the aim of fine tuning and avoiding unnecessary surgery. In both these instances, we do not know the long-term effect of these interventions on patient survival or quality of life. In this chapter, we will explore the available evidence on these applications and current advances in the new technology in general, with a specific focus on gynaecology.

Introduction

Imaging techniques play a crucial role in the diagnosis and management of disease. They are most widely used for diagnostic purposes and are normally undertaken well before surgical interventions. Increasingly, they are being used in the immediate (within 24 h) preoperative period to refine the surgical technique or immediate postoperative period to ensure correct performance of surgery or exclude operative adverse events. In this chapter, we focus on intraoperative imaging, with a brief

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reference to techniques used immediately before and after surgery, and cover the following imaging modalities: X-ray; interventional radiology; computed tomography; magnetic resonance (MRI); radionuclide imaging; positron emission tomography (PET); and ultrasound with or without contrast agents.

As far back as 1960, urinary tract stones were located by intraoperative radiofluoroscopy illumination with the aid of the roentgen image intensifier.[1] On the other hand, intraoperative ultrasound (IOUS), using A-mode or non-real-time B-mode imaging, which was also introduced in the 1960s, was not widely accepted because of the difficulty in image interpretation. The introduction of B-mode scanning in the late 1970s, however, and the ease with which images were interpreted, changed the attitudes and its use among the surgical specialties increased. Specially developed operative probes became more widely available from the 1980s onwards, and the use of IOUS spread worldwide in a number of surgical fields (i.e. hepatobiliary pancreatic surgery, neurosurgery and cardiovascular surgery) (Fig. 1). Intraoperative ultrasound changed hepatic surgery dramatically because it was the only modality that was capable of delineating and examining the interior of the liver during surgery. In the 1990s, colour Doppler became available, and laparoscopic techniques were introduced at around the same time, resulting in the incorporation of laparoscopic ultrasound into the operative procedure (Fig. 2). Clearly, this highlights the need for educating surgeons in the use of ultrasound for better surgical practice.[2] Ultrasound-guided procedures were reported in the 1970s, such as percutaneous fine-needle aspiration biopsy for the definitive diagnosis of pancreatic carcinoma.[3] Other modalities were added, such as intraoperative intracardiac echocardiography during left ventriculomyotomy, myectomy for hypertrophic subaortic stenosis,[4] and intraoperative skeletal scintigraphy for localisation of osteoid-osteoma in the spine.[5]

In gynaecology, ultrasound-guided oocyte retrieval by percutaneous aspiration was reported in 1985[6] and, in the same year, transvaginal ultrasound-guided egg recovery was reported.[7]

X-ray and magnetic resonance imaging of the abdomen and pelvis

In spite of the many advances in imaging techniques, plain X-ray still plays an important role intraoperatively in situations that the gynaecological surgeon may encounter. Examples of this include locating lost needles, instruments or swabs during surgery,[8] or lost intrauterine contraceptive devices that pelvic ultrasound scans fail to locate inside the uterus or in the pelvis. For this purpose, removing

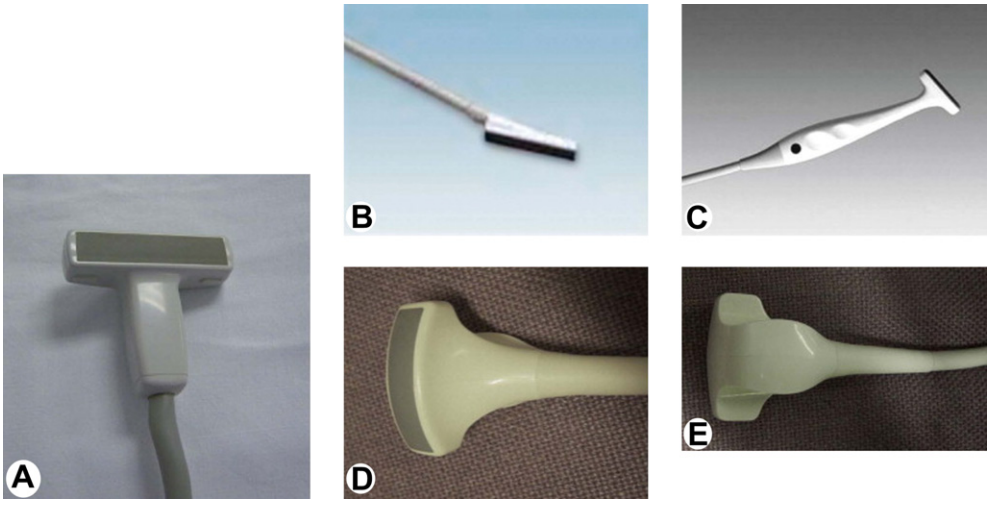

Fig. 1. Intraoperative ultrasound probes: (a) T probe; (b) 'I' shaped array; (c) an end-firing array; (d) a curved array, particularly useful for hepatic scanning with access to the dome of the liver; and (e) the back of the curved array is shaped to take the sonographer's fingers.