Fundamentals in Oncologic Ultrasound

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Fundamentals in Oncologic Ultrasound

Sonographic Imaging and Intervention
in the Cancer Patient

Foreword by David Cosgrove

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Foreword

It is a remarkable observation that human creativity can be fostered by spectacular scenery, itself usually the result of tectonic activity which raises mountains of beauty but carries the sting of earthquakes and eruptions. Think of Silicon Valley in California or of the Tokyo-Kyoto corridor in Eastern Japan. Another is the glorious Amalfi coast around Naples, where the authors of this new textbook work in the shadow of Mount Vesuvius. Is it the beauty that inspires or the tension of knowing that one's life may be shattered at any moment if a volcanic or tectonic disaster strikes? Whatever the explanation, these authors' passion for their subject shines through and their work carries not only their enthusiasm but also a rare beauty in its construction/format, for it is a joy to hold and behold with its beautiful all-colour printing and abundant illustrations of excellent quality, mainly, of course, ultrasound images but also corresponding CT scans and numerous elegant diagrams.

But, is there a need for a textbook on ultrasound in oncology? Doesn't everyone accept that CT or PET/CT (and sometimes MR) have nailed the problem of oncologic imaging? Well, while CT is undoubtedly the core imaging technique for the detection, staging, treatment planning and follow-up of tumours, there remain many applications for modern ultrasound, as readers of this textbook will be persuaded. It has the advantages of availability and ready repeatability and, in some situations, the lack of ionizing radiation is an advantage, even in oncology. Furthermore, it provides functional information, especially about blood flow, that may be critical in some oncology problems (choriocarcinoma is an example). It is also the best imaging modality for guiding interventional procedures.

The content of *Fundamentals in Oncologic Ultrasound* goes far beyond a narrow interpretation of the title, in that a wide range of non-tumour conditions is included and illustrated – in fact, wherever a non-tumour mass should be considered as part of the differential diagnosis, it is covered in detail here. This means that it will be indispensable to all clinics using ultrasound in general imaging. A wide-ranging introductory section covers the basics of ultrasound interpretation, including grey scale and Doppler, as well as microbubble contrast agents. In addition, unusually, there is a detailed discussion of the pros and cons of ultrasound compared with other imaging techniques, and a discussion of the benefits and dangers of screening, a topic that is often short-changed. There is also an important discussion of the use of imaging in evaluating response to treatment. As well as sections on the abdomen and superficial structures such as the head and neck, and the breast, there are sections on the genitourinary tract and one on the use of ultrasound to guide interventional procedures, including ablation techniques.

The authors are justifiably renowned for their careful, detailed and precise work in general ultrasound over many years. Their passion for the subject is evident in the detailed descriptions of the wide range of pathologies it includes, both adult and paediatric.

I congratulate Drs. Catalano, Nunziata and Siani on their labour of love and commend this excellent textbook to you.

London, February 2009

David Cosgrove
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Preface

Unlike other volumes of oncologic imaging, ours is not encyclopedic. It does not aim to analyze organ by organ every tumor which may be found there, with a systematic description regarding the etiopathogenetic, epidemiologic, clinical, diagnostic and therapeutic features of the disease. It does not begin, therefore, with a predetermined diagnosis but rather from the clinical problems that may lead there, because this is the reality of daily clinical practice. The volume is therefore structured in seven broad chapters.

Chapter 1. An analysis is made of the general relations between diagnostic imaging modalities, with particular reference to ultrasound, and the principal fields of oncology. An initial presentation is made of the advantages and limitations of US, the knowledge of which is essential for any clinical application of the technique, and therefore also for the study of cancer. The focus then shifts to the different phases in which US and the oncologic disease interact: secondary prevention, intrinsic characteristics of the cancer (with particular reference to neoangiogenesis), cancer staging, the evaluation of response to different types of anticancer treatments, short- and long-term monitoring, and the identification of disease recurrence. Only with an adequate understanding of these features of malignant disease can diagnostic imaging make a truly effective contribution. Chapter 1 also takes into consideration the examination techniques of US, spectral Doppler, color Doppler, power Doppler and contrast-enhanced US (CEUS), with particular reference to the study of neoplastic diseases in their superficial and deep locations. The presentation especially focuses on the current possibility of optimizing the US instrumentation and exploration technique, with the aim of maximizing the detection and morphofunctional analysis of neoplastic lesions. The sections dealing with the examination technique alternate with a presentation of the principal imaging characteristics: although tumors arising in different organs may display different features, the discussion aims to underline the common imaging characteristics so they can be applied from time to time to the various anatomic regions and clinical problems.

Chapters 2–6. The clinical problems connected either directly or indirectly to neoplastic disease of the different body regions are many and varied and can be included in a single volume only in part. Instead of an encyclopedic approach, with systematic discussion of the epidemiologic, clinical, diagnostic and imaging characteristics of the different neoplasms in different body regions, we preferred to begin with the basic clinical problem, which is how the disease is presented to the diagnostic imaging specialist. This approach involves, first of all, an illustration of the general appearance and then the imaging characteristics, first and foremost US, but also CD, spectral Doppler and CEUS.

Chapter 7. The current range of extravascular interventional procedures is extremely broad and constantly on the increase. This chapter describes the main US-guided procedures used in the cancer patient: diagnostic sampling of superficial and

deep lesions (both cytologic – FNAC, and histologic – core biopsy), vacuum-assisted biopsy in breast cancer, placement of presurgical markers, drainage of collections, cysts and liquefactive masses, percutaneous ablation (with special reference to percutaneous ethanol injection and radiofrequency thermal ablation, and especially with regard to focal hepatic lesions). It should, nonetheless, be borne in mind that the number of US-guided interventional procedures is much greater, ranging from biliary drainage to nephrostomy and nerve block for anesthesia or pain management to venous catheterization. US guidance, either alone or in combination with other modalities; this allows all of these procedures to be performed more effectively and with greater safety for the patient than with a “blind” approach”. An increasingly widespread diffusion of the technique can therefore be reasonably expected.

In this text the term color Doppler and its abbreviation CD are used, except where specifically stated, in reference to the Doppler techniques in general and therefore including power Doppler. In all cases where the description refers specifically to power Doppler this term will be expressly stated.

The term contrast-enhanced US (CEUS) is always used to refer specifically to gray-scale study with injection of sonographic contrast medium. When the intention is to indicate CD with contrast medium this is always expressly stated and should not be considered associated with the idea of US contrast enhancement.

Throughout the volume the term “US-guided” is a general reference to all procedures performed with US guidance, regardless of the type of transducer used, whether dedicated to the intervention or not. The specific meaning attributed to the terms “freehand”, “US-assisted” and “US-guided” is discussed at the beginning of Chapter 7.

Lastly, throughout the text, the term “biopsy” is used as a general indication of diagnostic sampling, both cytologic and microhistologic, where not otherwise specified. The difference between the former (aspirated with a fine needle, with the abbreviation FNAC) and true biopsy (indicated as “core biopsy”) is also thoroughly illustrated in Chapter 7. We preferred not to use the well-known abbreviation FNAB at all to avoid confusion in terms.

We thought it useful to provide a compact disc with video material of US examinations performed with various techniques. The choice appears appropriate especially given the difficulty in encapsulating in static images characteristics that can only be fully appreciated in real time, especially with regard to CEUS studies and interventional procedures.

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Abbreviations

3D	three-dimensional
µg	microgram
µm	micrometer
ABBI	advanced breast biopsy instrumentation
ACR	American College of Radiology
ACS	American Cancer Society
ACTH	adrenocorticotrophic hormone
AFP	α-fetoprotein
AI	acceleration index
AIDS	acquired immunodeficiency syndrome
BCLC	Barcelona Clinic Liver Cancer
BI-RADS	breast imaging reporting and data system
CA	cancer antigen
CD	color Doppler
CEA	carcinoembryonic antigen
CEUS	contrast-enhanced ultrasound
cm	centimeter
CT	computed tomography
CUP	cancer of unknown primary (tumor)
CVC	central venous catheter
dB	decibel
DPI	Doppler perfusion index
DRE	digital rectal examination
EFOV	extended field of view
EUS	endoscopic ultrasound
FDG	fluorodeoxyglucose
FIGO	International Federation of Gynecology and Obstetrics
F/M	female/male
FNAB	fine-needle aspiration biopsy
FNAC	fine-needle aspiration cytology
FNH	focal nodular hyperplasia
FOV	field of view
G	gauge
GIST	gastrointestinal stromal tumor
HBV	hepatitis B virus
HCC	hepatocellular carcinoma
HCG	human chorionic gonadotropin
HCV	hepatitis C virus
HIAA	hydroxy-indoleacetic acid
IOUS	intraoperative ultrasound
IU	international unit

IV	intravenous
Kg	kilogram
kHz	kiloHertz
L	liter
LABC	locally advanced breast cancer
LDH	lactic dehydrogenase
M/F	male/female
MALToma	tumor from mucous-associated lymphoid tissue
MEN	multiple endocrine neoplasm
mg	milligram
MHz	megaHertz
MI	mechanical index
MIBI	methoxyisobutylisonitrile
mL	milliliter
mm	millimeter
mmHg	millimeters of mercury
mPa	milliPascal
MRCP	magnetic resonance cholangiopancreatography
MR	magnetic resonance
MSCT	multislice computed tomography
MVD	microvessel density
ng	nanogram
NHL	non-Hodgkin's lymphoma
PACS	pictures archiving and communication system
PAT	percutaneous ablation therapy
PC	personal computer
PD	power Doppler
PEI	percutaneous ethanol injection
PET	positron emission tomography
PET-CT	PET and CT fusion
PI	pulsatility index
PIN	prostatic intraepithelial neoplasm
PLAP	placental alkaline phosphatase
PRF	pulse repetition frequency
PSA	prostate specific antigen
PSAD	prostate specific antigen density
PT	prothrombin time
PTT	partial thromboplastin time
QUART	quadrantectomy, axillectomy, radiation therapy
RCC	renal cell carcinoma
RECIST	response evaluation criteria in solid tumors
RF	radiofrequency
RFTA	radiofrequency thermal ablation
RI	resistive index
RIS	radiologic information system
ROI	region of interest
ROLL	radio-guided occult lesion localization
s	second
SD	standard deviation
SF ₆	sulfur hexafluoride
SPECT	single photon emission computed tomography
SUV	standardized uptake value
TACE	transcatheter arterial chemoembolization
Tc	technetium
Tis	tumor in situ
TNM	tumor – node – metastasis

TRUS	transrectal ultrasound
TSH	thyroid-stimulating hormone
TUR	transurethral resection
TVUS	transvaginal ultrasound
US	ultrasound
VB	vacuum-assisted biopsy
VEGF	vascular endothelial growth factor
$V_{\max}$	maximal velocity
V_m	mean velocity
$V_{\min}$	minimal velocity
vs.	versus
WHO	World Health Organization