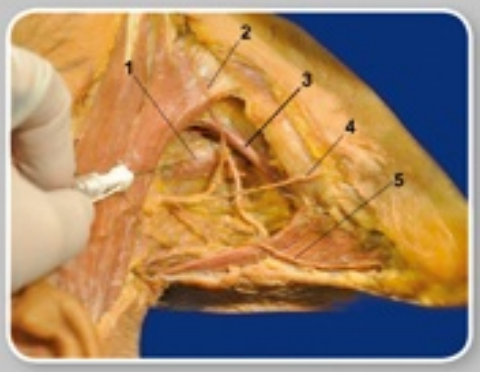
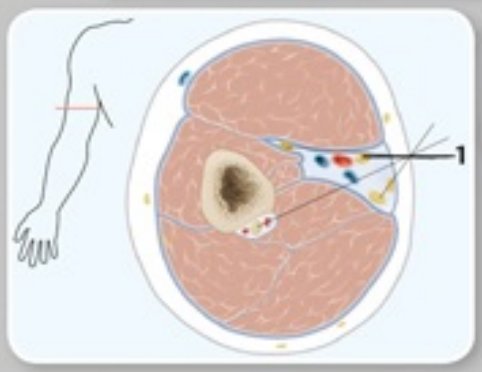
Atlas of Peripheral Regional Anesthesia

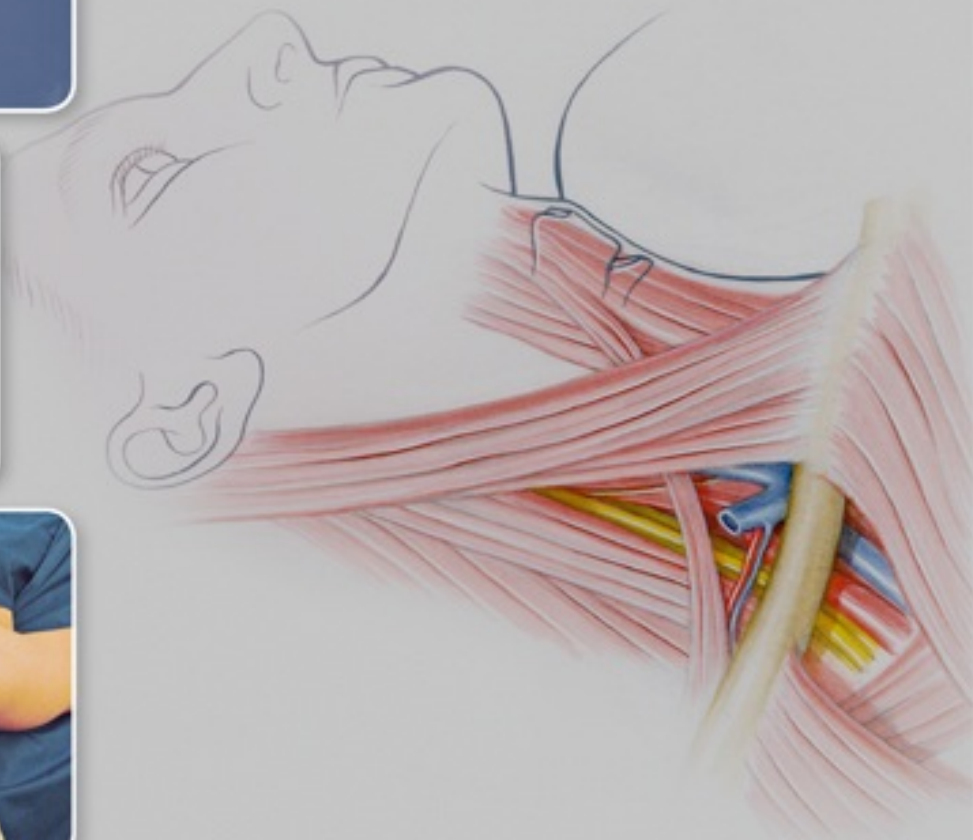
Anatomy and Techniques

Gisela Meier
Johannes Buettner

3rd Edition







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Foreword

Compared to general anesthesia, regional anesthesia can provide anatomically selective anesthesia with less interference with the patient's vital functions and a reduced need for opiates. Using a continuous catheter technique, the regional block can be transformed into a likewise selective analgesia with similar advantages for postoperative and other pain management.

Regional anesthesia is sometimes considered an art; this art can, however, be learnt by any interested anesthesiologist who has access to professional instructions and a good training program. The most exclusive form of regional anesthesia is peripheral nerve blockade, and for colleagues interested in practicing peripheral nerve and plexus blocks, this Atlas is an excellent source of clear and instructive descriptions of most clinically relevant extremity blocks. The art of peripheral nerve blockade is based on good anatomical understanding, careful handling of needles, catheters and patients, and good knowledge of pharmacology of local anesthetics. All these components are well presented in this Atlas.

Today's technology offers advanced assistance in localizing the target nerve; however, the use of electrostimulation or ultrasonography, for example, does not reduce the importance of anatomical knowledge. In my opinion, a competent anesthetist should also be able to find most peripheral nerves without this special equipment. And those readers who have carefully studied this Atlas will certainly be able to do that!

Dag E. Selander†
Nösund, Orust, Sweden

†This foreword to the 2nd English Edition was written in 2007 by Dag Selander, who sadly passed away 4 July 2013. In memory of this truly marvelous clinician, scientist, teacher, and above all human being, we decided to take over this foreword for the 3rd Edition, especially since it has lost none of its relevance.

Acknowledgements

The authors of this book consider themselves lucky to have had the continued support for many years of trusted colleagues and numerous friends. In the last decade we have been actively involved, both as speakers and tutors, in courses on anatomy for regional anesthesia and pain management at Innsbruck University and at the Medical University of Graz, Austria. Thanks to Drs. Christoph Huber, Gottfried Mitterschiffthaler, and Asst. Prof. Herbert Maurer and their courses, the field of anatomy has been opened up for special clinical and anesthesiological questions. Later on Professor Feigl started to arrange similar courses at the Institute for Anatomy, Medical University of Graz (Head Professor Dr. Anderhuber). During this time we were able to discuss various questions pertaining to peripheral blocking techniques. Together we carried out scientific research at the Department of Anatomy in order to clarify specific problems. Our special thanks go to all our colleagues and friends at Innsbruck University and the Medical University of Graz.

Other colleagues in Germany and Austria, both in Anesthesia and in Anatomy, have kindly cooperated with the authors over years. There has been a long-standing exchange of experience among them Profs. J. Jage and Stofft (Mainz University, Germany), Profs. Kessler and H.-W. Korf (Frankfurt University, Germany), Profs. T. Standl and Z. Halata (HamburgUniversity, Germany), Dr. M. Gründling and Prof. Fanghänel (Greifswald University, Germany), and Prof. B. Freitag and Dr. S. Rudolph (Klinikum Südstadt Rostock, Germany) were very collegial and helpful and their cooperation lead to many new findings. In these institutes the authors also had the chance to regulary clarify anatomical details relevant to peripheral blocking. We received support from numerous colleagues and apologize that we are unable to mention all of them here. We thank all the members of the institutes.

We are especially grateful that the anatomists allowed us to take photographs of their specimens. Many of the anatomical drawings for this book were produced by Mr. N. Lechenbauer. This was only possible with the support of B. Schmalz and R. Ploenes (AstraZeneca Co.). We also received active support in our own hospitals. Surgeons patiently waited for clinical pictures to be taken and members of staff made themselves available as test persons. Special thanks go to our staff. Dr. M. Neuburger (Klinikum Achern, Germany) has been kind enough to let us have research results and took additional photographs and performed extra examinations. Drs. D. Lang, F. Reisig. T. Geiser (Trauma Center, Murnau) and B. Bünten, A. Heuckerodt (Oberammergau Center for Rheumatology, Germany) have supported us in taking clinical pictures. Support from our own and other departments of our hospitals was so great that it is impossible to name everybody. We received a great deal of encouragement and many useful tips. This book is the result of many years of cooperation between anatomy and anesthesia. We would like to express our thanks to all those who have supported us along the way.

The *Atlas of Peripheral Regional Anesthesia* has won a lot of approval and recognition within the first month of publication in the German-speaking world. We thank Thieme Publisher's, notably Angelika Findgott and Joanne Stead, for their excellent cooperation and for making an English edition of this Atlas possible. We are proud to have acquired Dr. Dag

Selander for revision of the translation of the 2nd Edition. Dr. Selander was internationally renowned for his many publications in the field of regional anesthesia, including his article *Catheter technique in axillary plexus block* (Acta Anaesth Scand 1977; 21:324-329). He was the first to describe continuous percutaneus axillary brachial plexus anesthesia. We are honored that Dr. Selander agreed, as a specialist in this field, to edit the translation of the 2nd Edition and also supported us amicably with competent suggestions. We are grateful for this special support without which an English edition would have been impossible.

Panta rhei (Everything is in flux)

Heraklit (540-480 BC)

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General Aspects
General Principles for Performing Peripheral Blocks

Abbreviations

a.	artery
ACT	activated clotting time
ASS	acetyl salicylic acid
BART	blue away, red toward
CFM	color flow modus
CNB	central neuraxial block
COPD	chronic obstructive pulmonary disease
CRPS	complex regional pain syndrome
CW	continuous wave
ECT	ecarin clotting time
IP	in plane
IV	intravenous
LAST	local anesthetic systemic toxicity
LAX	long axis
LMH	low molcular weight heparin
LOR	loss of resistance
MRI	magnetic resonance imaging
OOP	out of plane
PCA	patient-controlled analgesia
PNS	peripheral nerve stimulation
PONV	postoperative nausea and vomiting
PRF	pulse repetition frequency
PW	pulsed wave
SAX	short axis
TAP	transversus abdominis plane
TGC	time gain concentration
THI	tissue harmonic imaging
v.	vein
VIB	vertical infraclavicular (plexus) block

Part 1

General Aspects of Ultrasound-Guided Peripheral Regional Anesthesia

1 General Principles of Ultrasound-Guided Peripheral Nerve Blocks

1 General Principles of Ultrasound-Guided Peripheral Nerve Blocks

1.1 Technical Requirements

1.1.1 Equipment

Portable, high-resolution ultrasound machines with interchangeable transducers now constitute devices that are well suited for use in anesthesiology and intensive medicine.

Types of Visualization

▸ **B-mode (brightness mode).** Every signal received from the transducer is displayed in a certain gray tone depending on its amplitude (intensity). The B-mode is used only in conjunction with the two-dimensional (2D) real-time mode. A two-dimensional image is made from the numerous ultrasound waves transmitted and received (▸ Fig. 1.1). Depending on the penetration depth and the type of probe used, just a few images or up to 200 images per second can be visualized.

▸ **M-mode (or TM-mode, time–motion).** An impulse is transmitted with a high pulse repetition rate (1,000–5,000/s). The amplitudes of the signals received are displayed on the vertical axis (one dimensional) in various gray tones; the horizontal axis is the time axis on which the signals received over time are displayed at short intervals according to frequency.

Note

The M-mode has almost no role in ultrasound-guided regional anesthesia.

The M-mode can be helpful for diagnosing pneumothorax (see below). When the visceral pleura glide normally along the parietal pleura, a homogeneous granular pattern can be visualized below the pleura in M-mode—in contrast to the horizontal lines that can be seen above the pleura in immobile tissue (▸ Fig. 1.2). If pneumothorax is present, the granular pattern below the pleura is replaced by horizontal lines (▸ Fig. 1.3).

Transducers

Linear array and curved array transducers are used (▸ Fig. 1.4).

▸ **Linear array transducer.** The *standard transducer* is the high-frequency linear array transducer. A multi-frequency transducer (e.g., 4.0–16 MHz), with the option of varying the frequency depending on the penetration depth required, is generally used. A special form of high-frequency linear probe known as a hockey stick linear array transducer is shaped so that it

can be used in small anatomical situations. Modern multi-frequency linear broadband transducers use an electronic phased array technique, allowing the beam to be directed at various angles (sector scanning by electronic pan both in the transmission and the receptor field).

▸ **Curved array transducer.** The curved array transducer (2.0–6.0 MHz) is used for blocks of deeper nerves.

Practical Note

The higher the frequency, the better the resolution—but the lower the penetration depth.

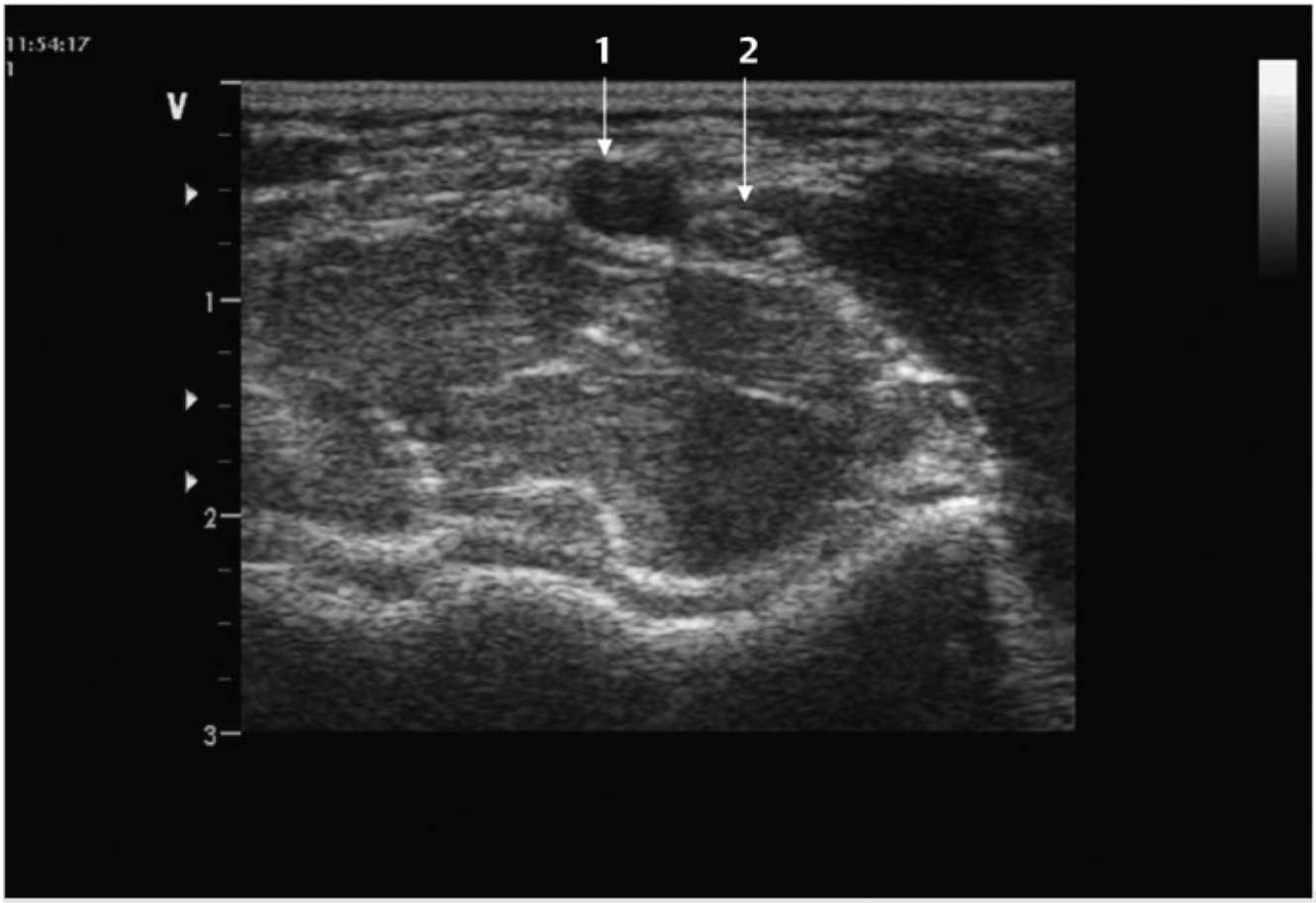

Fig. 1.1 Visualization of the elbow in B-mode (2D real-time mode).
1 Brachial artery
2 Median nerve

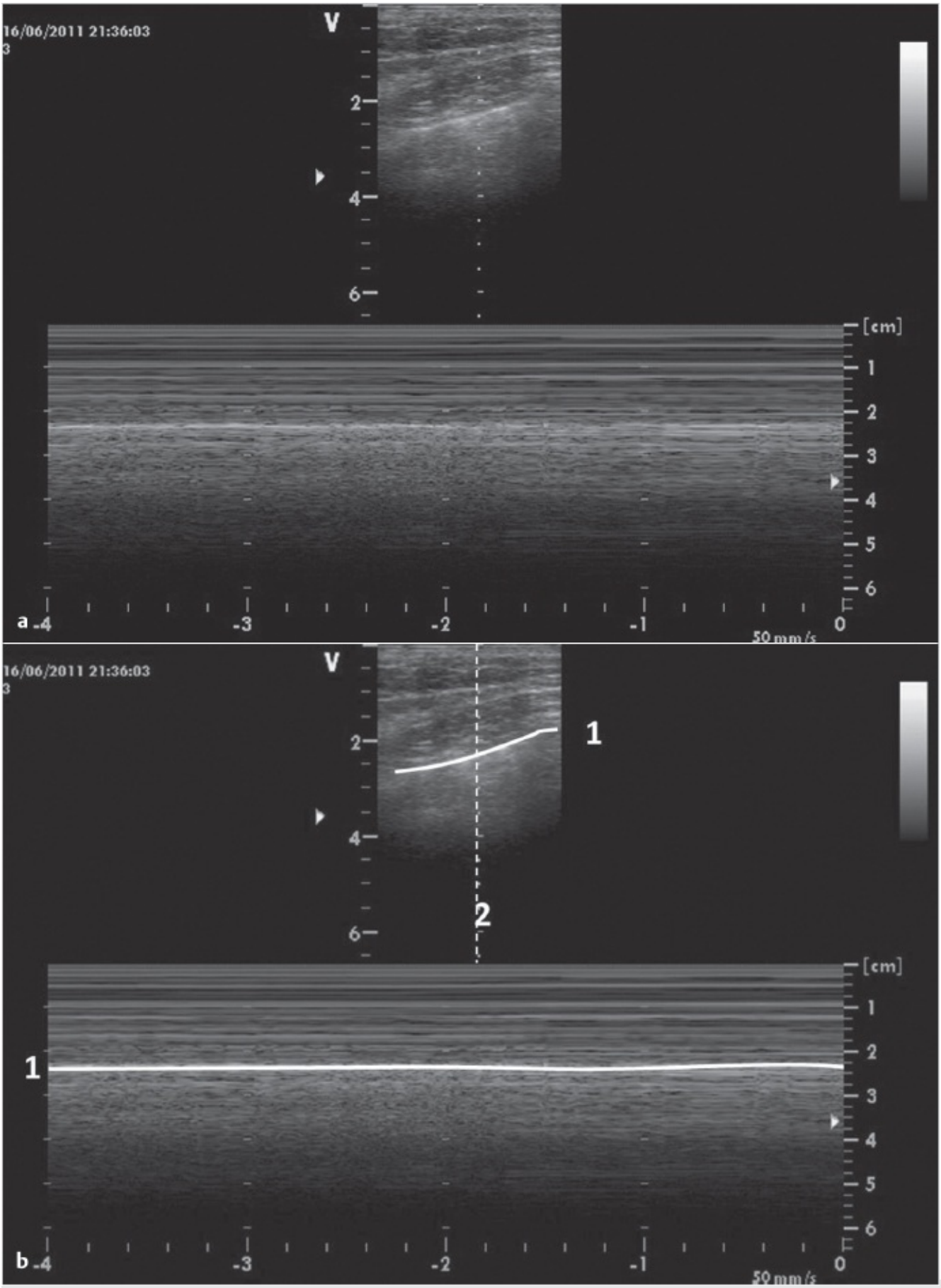

Fig. 1.2 Intact pleura in M-mode. **a** Small image at top: Pleura in B-mode indicating the ultrasound beam in which the M-mode was recorded.

b Intact pleura in M-mode labeled.
1 Pleura
2 Ultrasound beam with which the M-mode was recorded

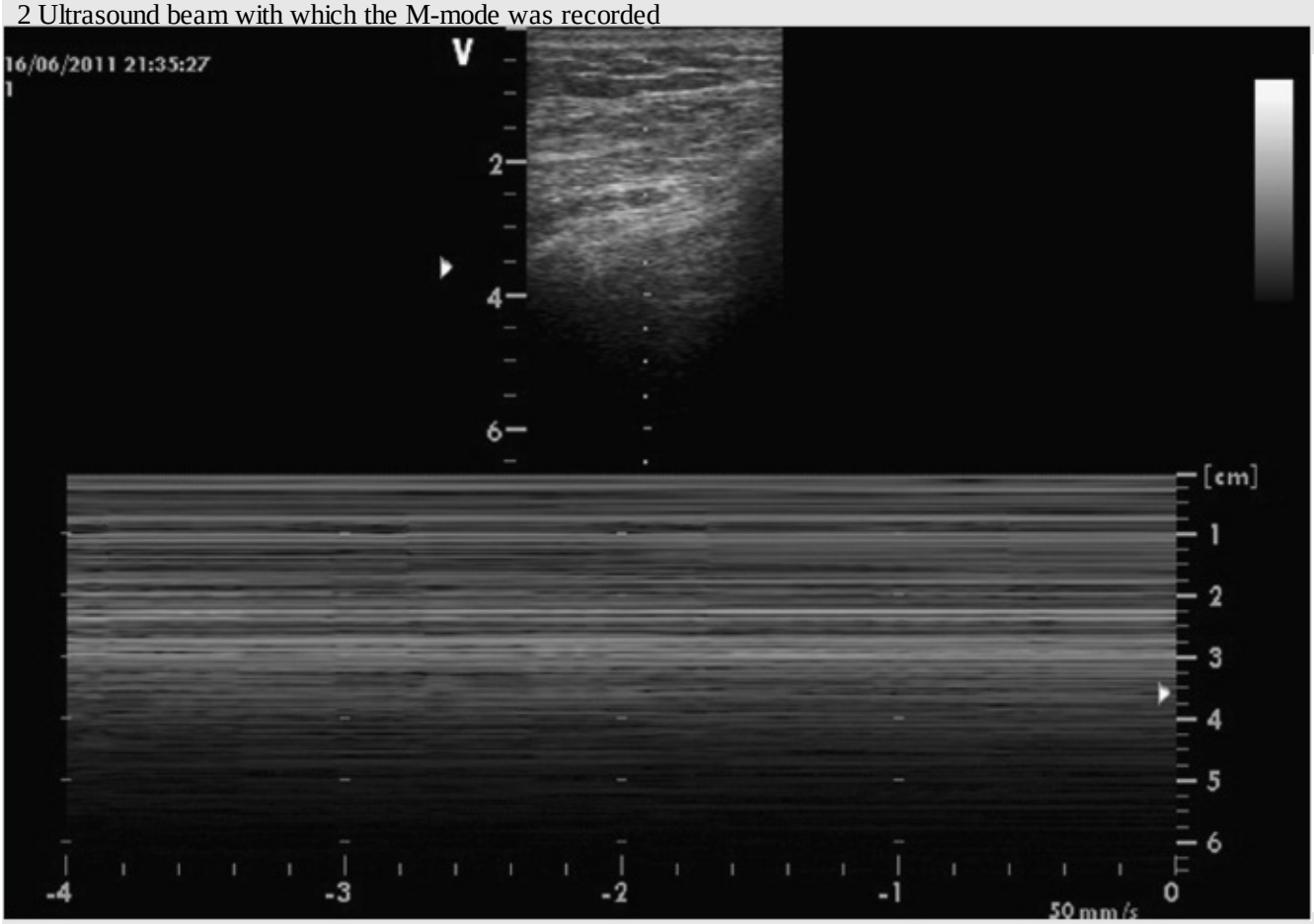

Fig. 1.3 Pleura in pneumothorax.