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The Royal Australian  
and New Zealand  
College of Ophthalmologists

# Ophthalmic Ultrasound Curriculum Standard

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## Purpose

The Ophthalmic Ultrasound Clinical Performance Standard covers the specific knowledge, processes, skills and competencies required for the diagnostic use of ultrasound for eye conditions.

Ophthalmic ultrasound is an essential diagnostic imaging modality. It allows for an assessment in appropriate contexts of ocular and periocular tissues, providing information leading to accurate diagnosis and more comprehensive management plans than would be possible from clinical examination alone. In particular, it serves a critical role in the diagnosis and management of many vitreoretinal (vitreous haemorrhage, retinal detachment), ocular oncology (especially melanoma) and trauma-related conditions, as well as in the exclusion of diseases where the view of the posterior segment is limited (e.g. white cataract, corneal scarring). Ultrasound is used to measure the length of the eye for calculating the power of an intra-ocular lens. Ultrasound is essential for this purpose in cases in which partial coherence interferometry cannot be used.

An understanding of relational anatomy of ocular tissues is critical for the interpretation of ocular imaging modalities. Ophthalmic ultrasound in particular integrates the ophthalmologist's unique expert knowledge of ocular anatomy with patient examination in a clinical setting to elucidate disease. Adequate topographic evaluation depends on the ophthalmologist's ability to think three-dimensionally while examining the globe with instruments that have only one- or two-dimensional display.

## References

### Ultrasound Reading

In addition to the core texts, the following references are recommended:

- Byrne, S.F. & Green, R.L. 2010, *Ultrasound of the eye and orbit*, 2nd edn, Jaypee Brothers Medical Publishers, New Delhi, India.
- or
- DiBernardo, C.W. & Greenberg E.F. 2006, *Ophthalmic ultrasound: a diagnostic atlas*, 2nd edn, Thieme Medical Publishers, Inc., New York, NY.

### Additional Reading

- Harrie, R.P. & Kendall, C.J. 2013, *Clinical ophthalmic echography: a case study approach*, 2nd edn, Springer, New York; Heidelberg,
- Harrie, R.P. 2011, *The ongoing role of ophthalmic ultrasound*, Review of Ophthalmology, Johnson Medical Information LLC, Pennsylvania, PA., accessed 16 January 2014, <<http://www.revophth.com/content/i/1448/c/27347/>>.
- Jamal, Y. 2012, *Ophthalmic ultrasound*, Slideshare, San Francisco, CA., accessed 16 January 2014, <<http://www.slideshare.net/yousaf82/ophthalmic-ultrasound>>.
- *Essential lectures in ophthalmic ultrasound*, Ophthalmic Edge LLC, Delray Beach, FL., accessed 16 January 2014, <<http://www.ophthalmicedge.org/essential-lectures-ophthalmic-ultrasound>>

The RANZCO Optics curriculum provides guidance on learning underpinning this standard. It is recommended that reading be supplemented with appropriate articles from current and relevant peer-reviewed journals.

## Level of Mastery

For each learning outcome, the level of mastery to be attained by the trainee at the end of training is indicated as follows:

***	Core knowledge of which trainees must be able to demonstrate understanding Skills and procedures that trainees must be able to perform autonomously
**	Knowledge of which trainees must have a good practical understanding Skills and procedures with which trainees should have assisted, and of which have good practical knowledge
*	Knowledge, skills and procedures of which trainees must have some understanding

## Learning outcomes and performance criteria

<b>OU1 ULTRASOUND PRINCIPLES</b>		
<i>This element covers the requisite knowledge and application of the principles of ophthalmic ultrasound.</i>		
<b>LEARNING OUTCOMES</b>	<b>LEVEL OF MASTERY</b>	<b>PERFORMANCE CRITERIA</b>
<b>1.1 Demonstrate knowledge of the physics of ultrasound generation, and the characteristic echoes produced at acoustic interfaces of different ocular media</b>	<b>***</b>	1.1.1 Describe: <ul style="list-style-type: none"> <li>• principles of sound waves</li> <li>• sound wave absorption and reflection</li> <li>• transduction</li> <li>• standard probes (8–10MHz)</li> <li>• ultrasound biomicroscopy (20–50MHz)</li> </ul>
<b>1.2 Demonstrate knowledge of the different methods of signal processing and their application in ophthalmology</b>	<b>***</b>	1.2.1 Describe the processes and applications for: <ul style="list-style-type: none"> <li>• A-scan (uni-dimensional) → quantitative information</li> <li>• B-scan (two-dimensional) → topographic information</li> <li>• time-based (kinetic) → dynamic information</li> </ul>
<b>1.3 Demonstrate knowledge of sources of variation in normal echography, especially instrumentation limitation and artefacts</b>	<b>*</b>	1.3.1 Describe the influences of the following sources of variation on ophthalmic ultrasound: <ul style="list-style-type: none"> <li>• insufficient fluid coupling</li> <li>• Baum’s bumps</li> <li>• gas or air bubbles</li> <li>• reverberations</li> <li>• scleral buckle</li> <li>• silicone oil</li> <li>• glaucoma shunt devices</li> </ul>
<b>1.4 Demonstrate knowledge of how echoes may be affected by various factors</b>	<b>*</b>	1.4.1 Describe how ultrasound echoes may be affected by: <ul style="list-style-type: none"> <li>• size and shapes of interfaces</li> <li>• angle of incidence</li> <li>• probe positioning</li> <li>• absorption</li> <li>• scattering</li> <li>• refraction</li> </ul>

<p><b>1.5 Demonstrate knowledge of the applications of and information obtained from the three primary B-scan probe positions</b></p>	<p><b>***</b></p>	<p>1.5.1 Describe the applications of and information obtained from the following B-scan probe positions:</p> <ul style="list-style-type: none"> <li>• transverse</li> <li>• longitudinal</li> <li>• axial</li> </ul>
<p><b>1.6 Synthesize your knowledge through performance and documentation of the purpose of standardised echography</b></p>	<p><b>***</b></p>	<p>1.6.1 Describe the purpose of standardised echography</p> <p>1.6.2 Perform ultrasound procedures</p> <p>1.6.3 Document and interpret ultrasound findings in a standardised fashion</p> <p>1.6.4 Maintain ultrasound diary:</p> <ul style="list-style-type: none"> <li>• record your experience of ophthalmic ultrasound in vitreoretinal/opaque media/trauma conditions</li> <li>• record your experience of ophthalmic ultrasound in ocular oncology conditions</li> </ul>

**OU2 ULTRASOUND ANATOMY**

*This element covers the requisite knowledge of ultrasound anatomy.*

LEARNING OUTCOMES	LEVEL OF MASTERY	PERFORMANCE CRITERIA
<p><b>2.1 Demonstrate knowledge of relational anatomy of ocular tissues</b></p>	<p>***</p>	<p>1.1.1 Describe and identify:</p> <ul style="list-style-type: none"> <li>• cornea</li> <li>• sclera</li> <li>• anterior chamber</li> <li>• trabecular meshwork</li> <li>• uveal tract</li> <li>• lens and zonules</li> <li>• vitreous</li> <li>• retina</li> <li>• choroid</li> <li>• optic nerve</li> <li>• orbit and optic canal</li> <li>• extra-ocular muscles</li> <li>• axial length</li> </ul>
<p><b>2.2 Apply ocular anatomy knowledge to ocular imaging modalities – in particular ultrasound</b></p>	<p>***</p>	<p>2.2.1 Describe the indications and procedures for:</p> <ul style="list-style-type: none"> <li>• A-scan</li> <li>• B-scan</li> </ul>
	<p>**</p>	<p>2.2.2 Describe the indications and procedures for:</p> <ul style="list-style-type: none"> <li>• Doppler</li> <li>• ultrasound biomicroscopy (UBM)</li> </ul>
<p><b>2.3 Demonstrate knowledge of normal developmental parameters of the globe and its structures, and common developmental variations</b></p>	<p>*</p>	<p>2.3.1 Describe the following ocular parameters, including its typical values and common developmental variations:</p> <ul style="list-style-type: none"> <li>• axial length</li> <li>• corneal curvature</li> <li>• anterior chamber depth</li> <li>• lens thickness</li> <li>• vitreous chamber depth</li> </ul>

<b>2.4 Demonstrate knowledge of normal functional changes in globe anatomy with age</b>	*	2.4.1 Describe the changes that occur as part of the normal ageing process in: <ul style="list-style-type: none"><li>• corneal curvature</li><li>• anterior chamber depth</li><li>• lens thickness</li><li>• axial length</li><li>• amplitude of accommodation</li><li>• refraction</li></ul>
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**OU3 ULTRASOUND INSTRUMENT APPLICATION AND SKILL ACQUISITION**

*This element covers the requisite knowledge of and skill using ultrasound techniques.*

LEARNING OUTCOMES	LEVEL OF MASTERY	PERFORMANCE CRITERIA
<p><b>3.1 Understand how to define sonographic parameters of instrument and the purpose of each</b></p>	<p style="text-align: center;"><b>*</b></p>	<p>3.1.1 Define and describe the purpose of:</p> <ul style="list-style-type: none"> <li>• screening below tissue sensitivity</li> <li>• screening at tissue sensitivity</li> <li>• screening above tissue sensitivity</li> </ul>
<p><b>3.2 Utilise different examination techniques to obtain sonographic information</b></p>	<p style="text-align: center;"><b>**</b></p>	<p>3.2.1 Demonstrate the following ocular sonographic techniques:</p> <ul style="list-style-type: none"> <li>• contact (esp. posterior segment) – on globe vs. through lids</li> <li>• immersion (esp. anterior segment)</li> </ul>
<p><b>3.3 Utilise B-scan ultrasound to determine the topographic nature of structures in the eye</b></p>	<p style="text-align: center;"><b>***</b></p>	<p>3.3.1 Determine and describe the location, extension and shape of ocular structures identified through ophthalmic ultrasonography</p>
<p><b>3.4 Utilise A-scan mode to determine the quantitative nature of structures in the eye</b></p>	<p style="text-align: center;"><b>**</b></p>	<p>3.4.1 Utilising A-scan mode, describe:</p> <ul style="list-style-type: none"> <li>• reflectivity estimate (spike height)</li> <li>• structure (internal architecture) – mass-like structures</li> <li>• sound attenuation (absorption)</li> <li>• reflectivity measurement (dB comparison) – membrane-like structures (e.g. posterior vitreous detachment vs. retinal detachment)</li> <li>• axial length measurement</li> </ul>
<p><b>3.5 Utilise kinetic echography techniques</b></p>	<p style="text-align: center;"><b>**</b></p>	<p>3.5.1 Determine the mobility (after movement) and vascularity (blood flow) of tissues</p>
<p><b>3.6 Utilise the three primary B-scan probe orientations to perform and report standardised examinations of the globe</b></p>	<p style="text-align: center;"><b>**</b></p>	<p>3.6.1 Demonstrate and describe the indications for using the following B-scan probe orientations:</p> <ul style="list-style-type: none"> <li>• transverse</li> <li>• longitudinal</li> <li>• axial</li> </ul>

<b>3.7 Utilise UBM techniques in assessment of anterior segment structures</b>	*	3.7.1 Demonstrate the use of UBM to assess: <ul style="list-style-type: none"><li>• cornea</li><li>• iris</li><li>• sclera</li><li>• ciliary body</li><li>• zonules</li><li>• pathophysiologic changes in anterior segment architecture</li></ul>
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<b>OU4 CLINICAL APPLICATIONS OF OPHTHALMIC ULTRASOUND</b>		
<i>This element covers the clinical applications of ophthalmic ultrasound.</i>		
<b>LEARNING OUTCOMES</b>	<b>LEVEL OF MASTERY</b>	<b>PERFORMANCE CRITERIA</b>
<b>4.1 Have a detailed understanding of the indications for ophthalmic ultrasound</b>	<b>***</b>	4.1.1 Describe the indications for ophthalmic ultrasound in: <ul style="list-style-type: none"> <li>• opaque ocular media</li> <li>• clear ocular media</li> <li>• biometry – independent of cataract work-up (e.g. monitoring paediatric glaucoma)</li> <li>• biometry when optical partial coherence interferometry fails to adequately assess axial length</li> </ul>
<b>4.2 Have detailed knowledge of and obtain clinical experience in performing ophthalmic ultrasound on patients with vitreo-retinal disease</b>	<b>***</b>	4.2.1 Perform ophthalmic ultrasound in cases of vitreous haemorrhage or other media opacity  4.2.2 Perform ophthalmic ultrasound to exclude the presence of posterior segment masses, as well as to distinguish retinal detachment from mimicking condition  4.2.3 Distinguish between different types of retinal detachment based on their sonographic features: <ul style="list-style-type: none"> <li>• rhegmatogenous</li> <li>• tractional (e.g. diabetic)</li> <li>• exudative (e.g. choroidal effusions, inflammations)</li> </ul> 4.2.4 Describe the sonographic features used to distinguish posterior vitreous detachment from retinal detachment

<p><b>4.3 Have detailed knowledge of and obtain clinical experience in performing ophthalmic ultrasound on patients with ocular oncologic disease</b></p>	<p><b>**</b></p>	<p>4.3.1 Utilise topographic, quantitative and kinetic examination techniques to provide echographic data; integrate these with your detailed knowledge of ocular pathology to optimise the management of ocular oncology patients</p> <p>4.3.2 Utilise standardised ophthalmic ultrasound examination techniques so that serial measurements can be reliably undertaken in the monitoring of ocular oncology patients and their response to treatment, as well as the detection of progression/recurrence</p>
<p><b>4.4 Understand the sonographic characteristics of common ocular oncologic disease in adult patients</b></p>	<p><b>*</b></p>	<p>4.4.1 Describe the sonographic characteristics of common ocular oncologic diseases in adult patients, in particular ocular melanoma (esp. choroidal and ciliary body)</p> <p>4.4.2 Describe the pathology and sonographic characteristics of differential diagnosis of choroidal melanoma:</p> <ul style="list-style-type: none"> <li>• choroidal haemangioma</li> <li>• metastatic carcinoma</li> <li>• disciform lesions</li> <li>• choroidal haemorrhages</li> <li>• choroidal osteoma</li> <li>• melanocytoma</li> </ul>
<p><b>4.5 Understand the sonographic characteristics of common ocular oncologic disease in paediatric patients</b></p>	<p><b>**</b></p>	<p>4.5.1 Describe the sonographic characteristics of common ocular oncologic diseases in paediatric patients, in particular retinoblastoma</p> <p>4.5.2 Describe the disorders and sonographic characteristics of differential diagnosis of retinoblastoma:</p> <ul style="list-style-type: none"> <li>• retinopathy of prematurity (ROP)</li> <li>• persistent foetal vasculature</li> <li>• Coats disease</li> <li>• endophthalmitis</li> <li>• toxocariasis</li> <li>• cysticercosis</li> </ul>

<p><b>4.6 Understand the role of ophthalmic ultrasound in trauma</b></p>	<p><b>**</b></p>	<p>4.6.1 Utilise ophthalmic ultrasound to diagnosis and localise intraocular foreign bodies</p> <p>4.6.2 Utilise ophthalmic ultrasound to provide evidence of lens and anterior segment disorders</p> <p>4.6.3 Utilise ophthalmic ultrasound to provide evidence of posterior segment disorders, including retinal detachment and posterior globe rupture</p> <p>4.6.4 Utilise ophthalmic ultrasound to assess and diagnose surgical trauma and complications, including:</p> <ul style="list-style-type: none"> <li>• infection/endophthalmitis</li> <li>• hypotony and choroidal effusions</li> <li>• retained lens material</li> <li>• haemorrhage – including suprachoroidal haemorrhage/expulsive haemorrhage</li> </ul> <p>4.6.5 Utilise ophthalmic ultrasound to provide evidence of anaesthetic (needle) trauma</p>
<p><b>4.7 Understand the role of ophthalmic ultrasound in uveitis/ocular inflammation</b></p>	<p><b>**</b></p>	<p>4.7.1 Utilise ophthalmic ultrasound in diagnosis or exclusion of posterior scleritis</p> <p>4.7.2 Utilise ophthalmic ultrasound in assessing choroidal thickening</p>
<p><b>4.8 Understand the role of ophthalmic ultrasound in assessing optic nerve disorders</b></p>	<p><b>*</b></p>	<p>4.8.1 Utilise ophthalmic ultrasound in diagnosing optic disc drusen and other optic nerve disorders</p>