

## EDITORIAL



# Handheld optical coherence tomography removes barriers to imaging the eyes of young children

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Optical coherence tomography (OCT) has revolutionised the clinical practice of ophthalmology. Its use has become widespread across most major branches of ophthalmology, including medical retina, surgical retina, glaucoma, neuro-ophthalmology, uveitis, cornea, anterior segment and refractive surgery, primary care ophthalmology and ocular oncology. However, conventional table-mounted OCT devices are not designed for infants and young children, who have previously been deprived of this technology and its many clinical benefits. Furthermore, many research studies using table-mounted OCT devices have previously excluded infants and young children.

Nicholson et al. [1] successfully used handheld spectral-domain OCT in a cohort of children with Down syndrome aged 4–11 years old. They demonstrated good feasibility of handheld OCT with successful scans in 12 out of 14 children (86%). Interestingly, at the fovea, they found that the ganglion cell layer and inner nuclear layer were thickened relative to the control group. At the parafovea, they found thickening of the retina attributable to numerous layers in both the inner and outer retina. They also reported a high incidence (67%) of foveal hypoplasia—higher than previously reported. All cases of foveal hypoplasia were grade 1 [2]; this is associated with a better visual prognosis than higher grades of foveal hypoplasia [3]. If visual acuity is poorer than expected for mild foveal hypoplasia, clinical suspicion should be raised for other pathology limiting the visual acuity. Other ocular conditions, such as infantile glaucoma, corneal ectasia or retinal pathology, can also be diagnosed and managed in this patient group with the advantages of handheld spectral-domain OCT.

Handheld OCT has been used to study the normal development of the fovea [4] from birth to adulthood, and the optic nerve head [5] from birth to adolescence. Handheld OCT has also been used to study a wide range of conditions affecting the paediatric population, providing useful diagnostic information, permitting serial monitoring, guiding clinical management and, in many cases, overcoming unique challenges in certain patient groups. Handheld OCT can be used in premature infants during the first days of life to evaluate retinopathy of prematurity (in dilated [6] and undilated [7] pupils), hypoxic-ischaemic encephalopathy [7] and obstructive hydrocephalus [7], without sedation. It is feasible and reliable in children with constant involuntary eye movements characteristic of nystagmus [3, 8, 9] and has been used to study the following associated conditions: foveal hypoplasia [3, 9], albinism [3, 9], achromatopsia [3], PAX6 mutations [9] and SLC38A8 mutations [10]. It has also been used in idiopathic infantile nystagmus [3, 9]. It has demonstrated good feasibility and repeatability in infants and young children with craniosynostosis [11], including its syndromic forms often associated with developmental delay. It has been used in children with primary congenital glaucoma [12, 13], anterior

segment dysgenesis [14], optic nerve hypoplasia [15], retinal detachment [16], retinoschisis [16], retinoblastoma [17], optic pathway gliomas [18] and other ocular conditions. It has also been used in children with other conditions affecting the skull and brain, including microcephaly [19], cerebral malaria [20] and in craniopagus twins conjoined at the skull [21].

Performing handheld OCT in children is both an art and a science. Specialised training in handheld OCT image acquisition is required. Under the right circumstances, children of all ages can be imaged in the eye clinic without sedation. Engaging the parents/carers can be hugely beneficial—once they understand the aim and purpose of the examination, they often become invested in achieving good imaging by keeping the child calm and offering their favourite toys/cartoons as visual fixation devices, as the handheld OCT does not feature an in-built fixation target. Undilated handheld OCT is feasible in most cases. Sometimes, dilating the child's pupils can be counter-productive, as it may distress them and make handheld OCT imaging more challenging. A short acquisition time can be used, e.g., 1.9 s, to facilitate successful image acquisition with minimal disruption of quality. The scan window can be adjusted to image both the fovea and optic nerve head in one scan, e.g. 12 mm × 8 mm. It can be beneficial to have one person aiming the handheld OCT probe and a second person using the computer to acquire the scan. The continuous real-time imaging 'free run' mode can be used, as this refreshes every 1.68 s, providing enough time to stop the acquisition and save the last acquired image—this is particularly useful in pre-verbal infants where cooperation and fixation can be more challenging. If a second person is not available, then the foot-pedal can be used to acquire images.

In babies, it can be useful to allow enough clinic time for the parents/carers to settle the baby prior to the examination, with particular emphasis on feeding. It is possible and sometimes easier to perform handheld OCT in a baby whilst they are napping by gently opening the lids. In an awake baby, provided they are not distressed, handheld OCT can still be performed without dilation. In toddlers, it can be very useful to have the parent/carer or a second clinician holding a visual fixation device, such as a toy or cartoon on a tablet/smartphone, moving this as instructed by the clinician operating the handheld OCT such that they visualise the structures of interest. As soon as the child is old enough to understand the purpose of the handheld OCT examination, it can be beneficial to explain the purpose of the examination so that they become invested in achieving good imaging too. Furthermore, in research studies, it can be beneficial for all parties to actively involve and engage children, parents and carers in all stages of the study [22].

Handheld OCT is a relatively young science with unique challenges, such as the need for specialist training in image acquisition and analysis, lack of in-built fixation target and currently there is no automated image segmentation/analysis programme. However, with specialised training, infants and young children of all ages can benefit from handheld OCT imaging.

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The author declares no competing interests.

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