2-1-1982

Anatomy of the normal peripheral fundus and the role of binocular indirect ophthalmoscopy in optometric practice

Clayton Y. Gushiken
Pacific University

Recommended Citation
https://commons.pacificu.edu/opt/622

This Thesis is brought to you for free and open access by the Theses, Dissertations and Capstone Projects at CommonKnowledge. It has been accepted for inclusion in College of Optometry by an authorized administrator of CommonKnowledge. For more information, please contact CommonKnowledge@pacificu.edu.
Anatomy of the normal peripheral fundus and the role of binocular indirect ophthalmoscopy in optometric practice

Abstract
Anatomy of the normal peripheral fundus and the role of binocular indirect ophthalmoscopy in optometric practice

Degree Type
Thesis

Rights
Terms of use for work posted in CommonKnowledge.
Copyright and terms of use

If you have downloaded this document directly from the web or from CommonKnowledge, see the “Rights” section on the previous page for the terms of use.

If you have received this document through an interlibrary loan/document delivery service, the following terms of use apply:

Copyright in this work is held by the author(s). You may download or print any portion of this document for personal use only, or for any use that is allowed by fair use (Title 17, §107 U.S.C.). Except for personal or fair use, you or your borrowing library may not reproduce, remix, republish, post, transmit, or distribute this document, or any portion thereof, without the permission of the copyright owner. [Note: If this document is licensed under a Creative Commons license (see “Rights” on the previous page) which allows broader usage rights, your use is governed by the terms of that license.]

Inquiries regarding further use of these materials should be addressed to: CommonKnowledge Rights, Pacific University Library, 2043 College Way, Forest Grove, OR 97116, (503) 352-7209. Email inquiries may be directed to: copyright@pacificu.edu

This thesis is available at CommonKnowledge: https://commons.pacificu.edu/opt/622
ANATOMY OF THE NORMAL PERIPHERAL FUNDUS
AND THE ROLE OF BINOCULAR INDIRECT OPHTHALMOSCOPY
IN OPTOMETRIC PRACTICE

A THESIS PRESENTED TO
THE FACULTY OF THE
COLLEGE OF OPTOMETRY
PACIFIC UNIVERSITY

IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE
DOCTOR OF OPTOMETRY

BY
CLAYTON Y. GUSHIKEN

ADVISOR: STEVE MARTIN, O.D.

FEBRUARY 1982
ANATOMY OF THE NORMAL PERIPHERAL FUNDUS AND THE ROLE OF BINOCULAR INDIRECT OPHTHALMOSCOPY IN OPTOMETRIC PRACTICE

TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Indications for Binocular Indirect Ophthalmoscopy</td>
<td>2</td>
</tr>
<tr>
<td>Contraindications Toward Binocular Indirect Ophthalmoscopy</td>
<td>3</td>
</tr>
<tr>
<td>Proper Screening and Drug Application</td>
<td>3</td>
</tr>
<tr>
<td>Suggested Clinical Routine</td>
<td>5</td>
</tr>
<tr>
<td>Where Can I Incorporate This Into My Present Routine?</td>
<td>6</td>
</tr>
<tr>
<td>Anatomy of the Normal Peripheral Fundus</td>
<td></td>
</tr>
<tr>
<td>Divisions of the Peripheral Fundus</td>
<td>7</td>
</tr>
<tr>
<td>Landmarks in the Periphery</td>
<td>8</td>
</tr>
<tr>
<td>Normal Anatomical Variations</td>
<td></td>
</tr>
<tr>
<td>Ora Bays and Dentate Processes</td>
<td>11</td>
</tr>
<tr>
<td>Meridional Folds</td>
<td>13</td>
</tr>
<tr>
<td>Meridional Complexes</td>
<td>14</td>
</tr>
<tr>
<td>Granular Tissue</td>
<td>14</td>
</tr>
<tr>
<td>Pars Plana Cysts</td>
<td>15</td>
</tr>
<tr>
<td>Ora Serrata Pearls</td>
<td>15</td>
</tr>
<tr>
<td>Referral Considerations</td>
<td>15</td>
</tr>
<tr>
<td>Summary and Conclusion</td>
<td>16</td>
</tr>
<tr>
<td>Bibliography</td>
<td>18</td>
</tr>
</tbody>
</table>
INTRODUCTION

With the current success rate of optometric DPA legislation, more and more optometrists will soon have the option of using drugs in their diagnostic examinations. Optometrists and optometry students will therefore find it necessary to acquire two things. The first, is the knowledge and understanding of what constitutes the normal peripheral fundus from the abnormal peripheral fundus. The second aspect concerns the instrumentation needed to examine the peripheral areas of the fundus. This thesis will focus on identifying the normal variations occurring in the peripheral retina in the hope that peripheral pathological conditions can be properly recognized and referred.
ANATOMY OF THE NORMAL PERIPHERAL FUNDUS AND THE ROLE OF
BINOCULAR INDIRECT OPHTHALMOSCOPY IN OPTOMETRIC PRACTICE

INDICATIONS FOR BINOCULAR INDIRECT OPHTHALMOSCOPY

Whether or not all patients should have a dilated examination with the binocular indirect ophthalmoscope is debatable and will be left up to the optometrist's own preference. However, there are certain signs and symptoms which point to an increased likelihood of peripheral retinal pathology. The following are indications that a peripheral fundus examination is necessary.

* Recent history of flashes and floaters
* A change in the pattern of floaters
* Unexplained visual loss
* Loss of peripheral vision
* Night blindness
* Significant ocular trauma
* Better observation of any abnormality in fundus
* Blood in or on the retina, or in the vitreous
* Posterior vitreous detachment
* History of retinal detachment
* Children: To rule out congenital ocular disease or retinoblastoma
* Premature child
* Esotropic child
* Monocular patients
* Diabetes for more than five years
* Moderate to high degree of myopia
* Presurgical cataract patients
* Post-surgical cataract patients
* Post-surgical strabismic patients
* To obtain a more complete overview of the central and peripheral fundus

CONTRAINDICATIONS TOWARD BINOCULAR INDIRECT OPHTHALMOSCOPY

When a peripheral fundus exam is deemed necessary, the majority of your patients can be handled quite adequately with the procedures to be outlined in the following pages. However, rarely, you may encounter a patient in your practice where the use of an anesthetic or mydriatic is contraindicated. Consequently, the binocular indirect ophthalmoscope will be very difficult or even impossible to use. Therefore, referrals to institutions that are equipped to handle these rare cases should be made when the patient shows any of the following:

* Known allergy towards anesthetic or mydriatics
* Narrow angle or history of narrow angle glaucoma
* Increased IOP
* Systemic medications which may potentiate the effects of phenylephrine; i.e., monamine oxidase inhibitors or tricyclic antidepressants
* History of hypertension, cardiac, or thyroid disease
* Certain types of intra-ocular lens implants.

PROPER SCREENING AND DRUG APPLICATION

To adequately examine the peripheral fundus with the BIO, full pupillary dilation is required. The following procedures should always precede drug instillation.
1. Case history:
   (a) Known allergies to "caine" drugs, i.e., dental anesthetic-novocaine.
   (b) General health (cardiac or thyroid disease)
   (c) Blood pressure
   (d) Eye surgery or diseases
   (e) Systemic medications
   (f) Special considerations which may necessitate rescheduling this procedure at a later date. For example: Student who has to study for an exam; or: Patient who has to drive fifty miles to get home on a sunny day.

2. Visual acuity

3. Slit lamp angle evaluation

4. Gonioscopy, if indicated

5. Tonometry

   After ruling out any contraindications, instill one drop of 0.5% proparacaine in each eye and wait ten seconds. Then instill one drop of 1% tropicamide (Mydriacyl) and one drop of 2.5% phenylephrine (Neosynephrine) in each eye.

   For each eye: One drop 0.5% proparacaine (anesthetic)  
   One drop 1.0% tropicamide (parasympatholytic)  
   One drop 2.5% phenylephrine (sympathomimetic)

   While waiting for adequate pupillary dilation, (20-30 minutes), the patient may be escorted to the frame room or to a special waiting room.
SUGGESTED CLINICAL ROUTINE

Once adequate pupillary dilation has occurred (6-7 mm. or greater), the fundus examination can proceed.

For best results, the patient should be reclining and the examiner should be sitting. This reduces fatigue on the examiner as well as allowing maximum comfort for both parties. A high stool on casters may be used, for this allows the examiner to sit and easily move around the patient's eye.\textsuperscript{13}

This author has found a successful adaptation of the "retinoscopy cartoon" when examining children. Through proper angling of any mirror on a stand, the cartoon can be projected onto the ceiling and this provides a useful fixation target.

In order to maintain patient cooperation, start with low illumination and examine the peripheral quadrants first.\textsuperscript{13} The following is offered as a beginning routine, until you become adept enough to develop your own.

<table>
<thead>
<tr>
<th>Examiner</th>
<th>Patient Fixates</th>
<th>Area of fundus seen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sits in back of patient's head</td>
<td>Toward his feet</td>
<td>Inferior periphery (figure 1)</td>
</tr>
<tr>
<td>Leans directly over the patient's head</td>
<td>Temporally</td>
<td>Temporal periphery (figure 2)</td>
</tr>
<tr>
<td>Sits on side of patient</td>
<td>Nasally</td>
<td>Nasal periphery (figure 3)</td>
</tr>
<tr>
<td>Leans over the patient's chest</td>
<td>Toward the top of his head</td>
<td>Superior periphery (figure 4)</td>
</tr>
<tr>
<td>Leans directly over the patient's head</td>
<td>Toward ceiling, primary gaze</td>
<td>Central fundus (figure 2)</td>
</tr>
</tbody>
</table>
The patient is then returned to the seating position and direct ophthalmoscopy is done for detailed observations. i.e., C/D ratio, vessel crossings, foveal reflex, etc.

WHERE CAN I INCORPORATE THIS INTO MY PRESENT ROUTINE?

Optometry's uniqueness stems from the fact that we do a lot of nearpoint testing. Therefore, dilation and the subsequent internal exam take place at the end of the visual analysis, after the analytical is completed, the angles evaluated, the intraocular pressures taken, and a thorough case history has been completed.

To summarize up to this point:

* Case history (drug allergies, medical history, special considerations)
* Visual acuity
* Entrance tests – cover test, eye movements, etc.
* External exam
* Analytical/prescription determination
* Slit lamp angle evaluation
* Gonioscopy, if indicated
* Tonometry
* Drop patient (anesthetic, S-mimetic, P-lytic)

* Waiting room or frame selection

* Binocular indirect ophthalmoscopy

* Direct ophthalmoscopy

* Patient is given post-mydriatic sunglasses upon leaving

At this point, you may feel that all of this is very time-consuming. Not true. If your present exam routine takes one hour and this includes dispensing of glasses - then the addition of these procedures will, at most, take fifteen minutes to perform.

  * 30 mins: Your usual exam minus ophthalmoscopy
  ** 5 mins: Screening and drug instillation
  * 30 mins: Frame selection while patient is dilating
  ** 10 mins: Indirect and direct ophthalmoscopy

1 hour, 15 mins.

ANATOMY OF THE NORMAL PERIPHERAL FUNDUS

DIVISIONS OF THE PERIPHERAL FUNDUS

The peripheral fundus is separated from the central fundus by an imaginary line passing through the scleral entrance of each vortex vein. A scleral entrance is usually visible in every quadrant and is located about two disc diameters (3.0 mm.) posterior to the equator. The scleral entrance is characterized by a black crescent of pigmented adventitia which limits the posterior extremity of a dark-red vortex vein. The peripheral fundus extends from this circular boundary to the middle of the pars plana ciliaris.

The peripheral fundus is further subdivided into two sections,
an equatorial region and an ora serrata region. The equatorial region is a ring-shaped area approximately four disc diameters (5.83 mm.) wide, extending on either side of the equator for about two disc diameters. The ora serrata region or oral region is another ring about three disc diameters wide, extending on either side of the ora serrata. (Figures 5 and 6).

![Fig. 5](image1.png) ![Fig. 6](image2.png)

LANDMARKS IN THE PERIPHERY

By far, the easiest structures to observe in the periphery are the vortex veins which number between 4 to 15 per eye. As mentioned earlier, observation of these veins means that you have just entered the peripheral fundus. Rutnin differentiated the various vortex vessels into four morphological types. (Figures 7,8,9,10)

**Type 1:** All tributaries converge directly to the scleral canal, vortex vein is absent.

**Type 2:** Vortex vein enters the scleral canal before all of its tributaries can feed into it.

**Type 3:** Vortex vein enters the scleral canal after all of its tributaries have drained into it.

**Type 4:** Vortex vein forms an ampulla (sac-like dilatation) before entering the scleral canal.
As you move more peripherally, the long ciliary nerves and arteries may become visible in the nasal or temporal periphery. These structures form the horizontal boundary. The appearance of a long ciliary nerve is similar to a flat egg noodle measuring about one-third of a disc diameter in width. The artery may appear as a thin, red line running adjacent and parallel to the nerve. When seen, both the nerve and artery usually begin at half the distance between the disc and equator and end at the ora serrata. (Figure 11)

The short ciliary nerves and arteries form the vertical boundary. They are located one quarter hour nasal to the 6 o'clock position and one quarter hour temporal to the 12 o'clock position. They form boundaries between the temporal and nasal vortex systems, but most of them cannot be seen with the indirect ophthalmoscope. (Figure 11).

The retinal arterioles and venules generally do not course together in the periphery, but instead are evenly distributed. In the periphery, it is often difficult to determine whether a vessel is an artery or vein on the basis of size, color, or pattern. Differentiation can usually be made by tracing the vessel back to the central fundus.
While it is often said that the ora serrata can only be viewed with scleral depression, exceptions to this rule do occur, so it is necessary to look at this area more closely.

The **ora serrata** is the boundary at which the photosensitive retina stops abruptly and is continued by the non-pigmented ciliary epithelium. In the adult, the ora serrata appears scalloped (dentate processes and bays) on the nasal side and as a slightly wavy line on the temporal side. (Figure 11) The scalloped appearance in the adult is the result of asymmetrical growth of the pars plana ciliaris. In the infant, the ora serrata appears as a slightly wavy line symmetrical all the way around the fundus. The ora teeth (dentate processes) and ora bays formed by scalloping of the ora serrata become obvious at about one-half hour temporal to the 12 o'clock meridian.

Measurements as to the size of the ora teeth range from 0.38 to 1.5 mm. (Rutnin and Schepens), to 0.50 to 2.5 mm. (Straatsma, et al). The bays have the same dimensions - being the posterior indentation in the retina (teeth are anterior extensions of the retina). (Figure 12). Because bays and teeth become harder to identify temporally, the exact number is hard to calculate. Estimates run between 20 and 30.
Posteriorly, the **pars plana** is delineated by the **ora serrata**. Anteriorly, it is delineated by the posterior margins of the ciliary processes. As mentioned earlier, the sensory retina is continued into the pars plana as the non-pigmented ciliary epithelium. Because the vitreous base straddles this region and is firmly adherent to the sensory retina and pigment epithelium, breaks in the non-pigmented epithelium can occur and lead to rhegmatogenous retinal detachment.\(^{19}\) (Figure 13)

The average width of the pars plana from the posterior margins of the ciliary process to the ora serrata is 4 mm. Radial striations can be seen here and often these line up with the dentate processes and are directed between the ciliary processes. (Figure 12).

**NORMAL ANATOMICAL VARIATIONS**

**ORA BAYS AND DENTATE PROCESSES**

Wide variations in the contour of the ora serrata have been demonstrated in numerous studies.\(^{16,21,23}\) Variations of size and shape include: deep bays, giant teeth, forked teeth, open-ring teeth, closed-ring teeth, hole in the tooth, bridging tooth, doubled ora bay, and retinal tag in ora bay. Deep ora bays are probably one of the most common findings, and generally these are accompanied by variations in the dentate processes.

The following definitions were synthesized from various authors:

- **Deep ora bay**: A posterior indentation in the retina which is usually two to four times wider and deeper than adjacent bays. (Figure 14A)

- **Giant tooth**: An anterior extension of the retina which may extend beyond the middle of the pars plana ciliaris and almost touch the ciliary processes. (Figure 14B)
**Forked tooth:** An anterior extension which is usually larger than average and has a bifurcated tip. (Figure 15A)

**Open-ring tooth:** Two adjacent teeth leaning toward each other but not quite touching so as to form a ring enclosing a bay. Also called a partially enclosed ora bay. (Figure 15B)

**Closed-ring tooth:** Two adjacent teeth leaning toward each other and joining, so as to form a ring enclosing a bay. (Figure 16A)

**Hole in the tooth:** Two adjacent teeth leaning toward each other and solidly merging into a single wide tooth. The enclosed island of pars plana ciliaris is much smaller than one in a closed-ring tooth. Also called enclosed ora bay. (Figure 16B)

**Bridging tooth:** An anterior extension of the retina usually appearing degenerated and cystic, which extends to the anterior portion of the pars plana ciliaris. It comprises one aspect of a meridional complex. Also called zonular traction tuft. (Figure 17A)

**Doubled ora bay:** Two adjacent bays which are separated by an abbreviated tooth. (Figure 17B)

**Retinal tag in ora bay:** An anterior projection of the retina which originates at the posterior margin of an ora bay. Generally, half of these tags extend into the vitreous cavity, yet have no known clinical significance. (Figure 18A)
Of clinical significance to all of the above is that Poos, in a study on 1,000 autopsy eyes, showed that enclosed ora bays (hole in the tooth) were present in four percent of the eyes and partially enclosed bays (open-ring tooth) in 0.6 percent. A retinal tear was associated with 16.7 percent of either type of ora bay and occurred posterior to and meridionally aligned with such bays.\textsuperscript{23}

\textbf{MERIDIONAL FOLDS}

A meridional fold, sometimes called a radial fold, is a radially aligned elevation of the peripheral retina. It is generally between 0.5 to 1.5 disc diameters in length and involves all retinal layers.\textsuperscript{16,24} As a rule, such a fold begins at the ora serrata and runs posteriorly and perpendicularly to it in a meridional fashion. (Figure 18B). The surface of a meridional fold lacks transparency and appears whiter than its surrounding structures. It is often a part of a meridional complex and is frequently found in the upper nasal quadrant. If a retinal detachment occurs in an eye with meridional folds, the retinal breaks tend to be located near the folds. Therefore, in cases such as this, the optometrist must search carefully in these areas for any associated retinal breaks.
MERIDIONAL COMPLEXES

When a meridional fold extends to the posterior aspect of a ciliary process, this is called a meridional complex. (Figure 17A). The fundamental feature of a meridional complex is an atypical dentate process (bridging tooth) that aligns with a ciliary process. A meridional complex may also be the site of small retinal breaks, so careful examination is required in patients with retinal detachment.

GRANULAR TISSUE

Another variation found in the peripheral retina is areas of granular tissue. The ophthalmoscopic picture is that of an opaque whitish-gray spot with a dull granular surface which protrudes slightly at the inner surface of the retina.

There are several morphological types:

Granular patch: A slightly raised plaque on the inner surface of the retina having an irregular but well outlined border. They frequently have a more or less round shape and their size varies from one-eighth to one-third disc diameter. They may appear as isolated areas of cystoid degeneration. (Figures 19A and 19B).

Granular globule: An irregular mass of one-twelfth to one-fifth disc diameter, protruding at the inner surface of the retina. Some are elongated like a column or club, and a few coarse and taut vitreous strands may be seen attached to the top of one of these globules. Retinal breaks can occur here. (Figure 20A).

Granular tags or floaters: A piece of degenerated granular tissue which is pulled into the vitreous cavity. Its appearance is modified by vitreous traction and may appear shrunken, curled, or so markedly distorted that it is impossible to determine its original shape. Retinal flap tears may occur posterior to them. (Figure 20B).
**PARS PLANA CYSTS**

Cysts of the pars plana consist of a clear cystoid space between pigmented and non-pigmented epithelium. Ophthalmoscopically, they appear as translucent bullous elevations located anterior to the ora serrata. In general, the cysts have a smooth surface, yet may also appear as half-inflated balloons. As a rule, the overlying vitreous and its surrounding ciliary and pigmented epithelium remained unchanged. No definite relationship has been established with any type of eye pathology. Unlike many of the other variations, pars plana cysts show a significant preference for the temporal half. (Figure 21A).

**ORA SERRATA PEARLS**

An ora serrata pearl appears as a discrete, glistening, spherical body which usually forms over an ora tooth. Its size varies from pinpoint to pinhead. These pearls are shown to be drusen-like structures and are probably of developmental origin. They occur throughout the ora serrata region and are not related to other fundus pathology. (Figure 21B).

**REFERRAL CONSIDERATIONS**

In order to observe the full extent of the oral region, scleral
depression is necessary. However, in general optometric practice, examination up to the posterior oral region without scleral depression is proper management if no signs and symptoms of a detachment are present.

If signs and symptoms of a retinal detachment are present and the general optometrist (or general ophthalmologist) cannot guarantee the absence of a retinal break, he should urgently refer the patient to a retina specialist. Early diagnosis of a detachment will lead to better post-operative visual results and this will depend largely upon what role the general optometrist is prepared to play.

This author has not had sufficient practice in scleral depressing, and feels that optometrists should refer their patients to a retina specialist if this procedure is indicated. Should the reader be interested in learning how to practice scleral indentation, Havener29 provides an excellent method.

**SUMMARY AND CONCLUSION**

This thesis has focused on identifying the normal variations occurring in the peripheral retina. Other variations in the peripheral fundus have been previously discussed by others.1-4,17-21 Some of these are classified as degenerative changes and are generally of no clinical significance.

Reading the references at the end of this thesis is highly recommended in order to understand the variations which are not so "normal". While the general optometrist may not have had the opportunity to become familiar with the variety of peripheral pathological conditions that exist, a thorough knowledge of these normal variations will insure that our patients receive 1980 primary optometric eye care.
Difficulties while first attempting this procedure often discourage the optometrist from attaining the skill necessary to perform the examination. However, with daily practice, indirect ophthalmoscopy will become a time-saving method of examination and a valuable means of gaining information otherwise inaccessibly hidden within the diseased eye.
BIBLIOGRAPHY


NOTE: Many of the illustrations were modified from Drs. V. Rutnin and C.L. Schepens.