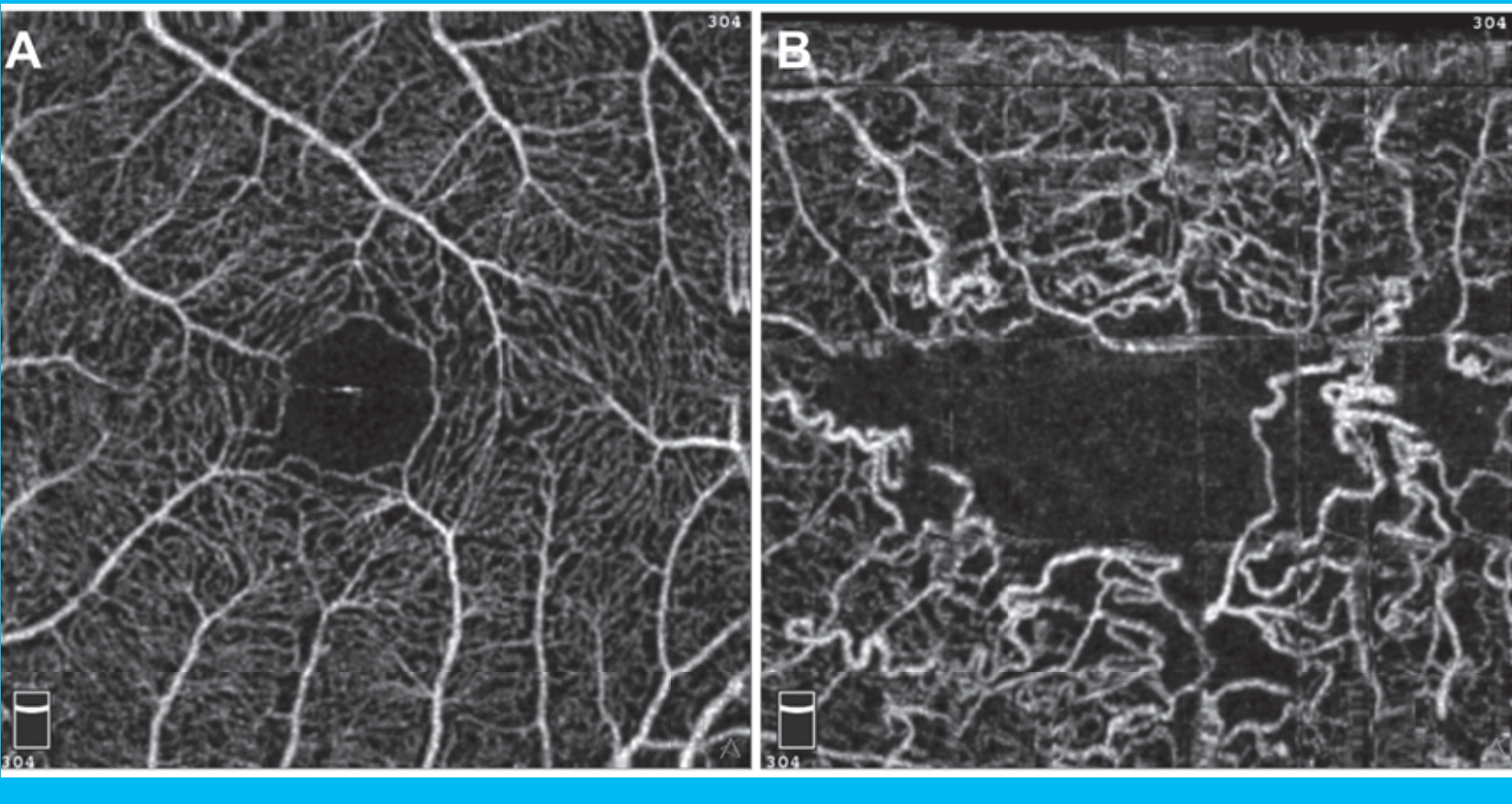
The Official Newsletter of the

VITREO RETINAL SOCIETY - INDIA

September 2017



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...delivers extended protection

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Guidelines for the manuscript submission in VRSI Newsletter

Original articles:

These include randomized controlled trials, intervention studies, studies of screening and diagnostic test, outcome studies, cost effectiveness analyses, case-control series, and surveys with high response rate. The text of original articles amounting to up to 3000 words (excluding Abstract, references and Tables) should be divided into sections with the headings Abstract, Key-words, Introduction, Material and Methods, Results, Discussion, References, Tables and Figure legends.

Case reports / Challenging case /Innovations / Instruments / Techniques

New, interesting, challenging, rare cases, innovations, instruments and techniques can be reported. They should be unique and providing learning point for the readers. Manuscripts with clinical significance or implications will be given priority. These communications could be of up to 1000 words (excluding Abstract and references) and should have the following headings: Abstract (unstructured), Key-words, Introduction, Case, Discussion, Reference, Tables and Legends in that order.

The manuscript could be of up to 1000 words (excluding references and abstract) and could be supported with up to 10 references. Case Reports could be authored by up to four authors.

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From the President's Desk

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Dear Members:

Greetings from the Vitreo Retinal Society-India!

The second issue of the VRS-I newsletter is dedicated to OCT Angiography and I hope this booklet will serve as a very useful guide for all retina specialists to interpret and understand OCT Angiography in their clinical practice. Dye-less imaging is slowly gaining popularity and is helping us to understand the evolution and pathogenesis of many macular diseases. In this context the scientific committee of the VRS-I felt that any additional knowledge in this emerging area would be of great interest and exciting.

The year 2017 has been a wonderful year for the members of the VRS-I with some of our members winning the best video award at the recently held ASRS. It is heartening to note that the best video award at the EURETINA meeting held in Barcelona, Spain, was also awarded to Dr Subendra Boral, one of our very active members.

Looking forward to meeting you all in Bhubaneswar for the XXVI annual conference to be held between November 30th and December 3rd, 2017.

With best wishes!

From the Honorary Secretary's Desk

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Dear Friends:

Greetings from the Vitreo Retinal Society-India!

Greetings from VRSI. I am delighted to know that the second issue of VRSI newsletter in 2017 is being published under the leadership of Dr. Vishali Gupta, Dr. Thomas Cherian, Dr. Anand Rajendran, Dr. Ramandeep Singh, and Dr. Jay Chhablani. I am sure that you will find the scientific information extremely valuable for your daily practice, and to provide the best care to your patients in the clinic. I take this opportunity to request you all to submit your interesting cases, articles and innovations to the VRSI newsletter, which will help improve the scientific knowledge base of our members.

VRSI is also holding the annual meeting at Bhubaneswar from Nov 30 to Dec 3, 2017, under the stewardship of Dr. S. T. Muralidhar, Dr. Santosh Mahapatra and Dr. Umesh Behera. Dr. Vishali Gupta is creating a wonderful scientific program for us all, with numerous International and National faculty, to make it a memorable event. I request you all to participate enthusiastically in both the meetings.

I wish you a great year ahead.

From the Convenor Scientific Committee Desk

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Dear Members:

Greetings from the Vitreo Retinal Society-India!

It gives me immense pleasure in bringing out the second edition of VRSI Newsletter in the year 2017. I would take this opportunity to thank all the members for appreciating the contents of previous newsletter and do hope that you would enjoy reading this one too.

Retinal Imaging is a part and parcel of day to day retina practice and ever evolving technology makes it a challenge to be up to date with the latest. OCT Angiography is one such technology that has created a lot of excitement amongst the retina fraternity because of the 'dye less' nature of the angiogram. OCT Angio is non-invasive, less time consuming with no discomfort to the patient. That makes it an attractive tool to use. However, it has limitations in term of motion and projection artifacts as well as limited field of scan. Also the retinal circulation can be studied in the segment selected. This requires a new learning that is different from the convention fluorescein angiograms. So, we have dedicated this newsletter to 'OCT Angiography' and tried to cover different aspects of this investigation that would be useful for a practicing Retina doctor.

I would like to thank all our international and national colleagues who have taken the time out of their busy schedules to contribute towards the newsletter. VRSI is truly blessed to have a great team of Dr. Ramandeep Singh, Dr.Anand Rajendran and Dr.Thomas Cherian who are the editorial board members and are working tirelessly to bring out newsletter timely.

We do hope that you will enjoy reading this and look forward to receiving your feedback to help us improve further.

Current Role of OCT Angiography in Vitreoretinal Diseases:
OCTA in Polypoidal Choroidal Vasculopathy

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Optical coherence tomography angiography (OCT-A) is a novel, non-invasive imaging modality that can evaluate blood flow within the retina with high resolution down to capillary level within seconds. This technology allows depth-resolved analysis of the retinal vasculature, allowing detailed assessment of the superficial, mid and deep retinal capillary plexuses, as well as outer retinal and choriocapillaris.[1] The principle is based on acquiring a series of B scans at the same transverse location, followed by registration, and calculation of the degree of decorrelation in signal. Any decorrelation between consecutive scans is assumed to result from movement of red blood cells. This procedure is repeated for different Y-positions in the retina to achieve a 3D dataset for which proprietary algorithms such as split-spectrum amplitude-decorrelation angiography (SSADA), optical microangiography (OMAG), and OCT angiography ratio analysis (OCTARA) are used to reconstruct en face angiograms.[1]

Polypoidal choroidal vasculopathy (PCV) is a subtype of choroidal neovascularization (CNV) characterized by polypoidal dilations and branching vascular networks (BVN) seen on indocyanine green angiography (ICGA) (Figure 1), which is the gold standard diagnostic tool.[2] On OCT, PCV lesions typically appear as dome-like elevation of the retinal pigment epithelium (RPE) within which polyps may be seen as round lesion(s) with moderate internal reflectivity, while BVN typically appears as undulating RPE line over the Bruch's membrane (BM) line ("double layer sign").[2] Fig.1

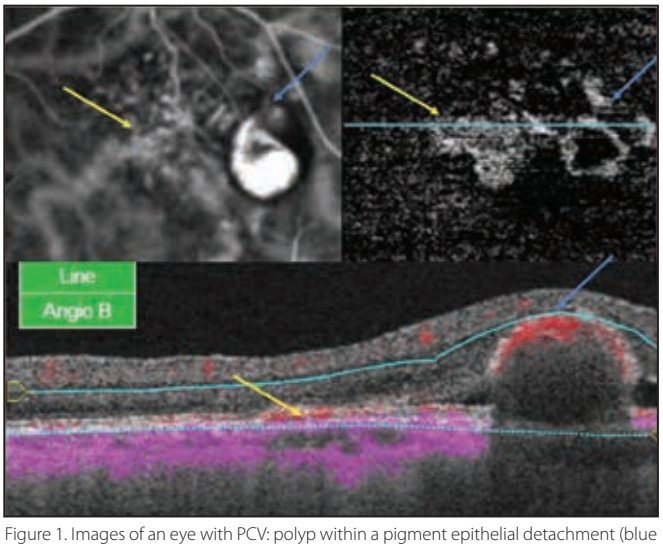

Figure 1. Images of an eye with PCV: polyp within a pigment epithelial detachment (blue arrow) and branching vascular network (yellow arrow) on ICGA (top left), OCT-A (top right), and OCT (bottom) in a 70 year old male.

Several studies have evaluated the performance of OCT-A in detecting PCV.[3-6] The BVN typically appears as hyperflow vascular network in the outer retina or choriocapillaris slabs (Figure 1), whereas polyps may appear as hyperflow or hypoflow (Figure 1) round structures.[3-6] In one study, 12/13 eyes (92.3%) showed polypoidal lesions with high flow signals in the outer retina slab on OCT-A, and, anatomically, these polyps were located under the top of the pigment epithelial detachment (PED).[4] BVNs, on the other hand, were seen in all 13 eyes (100%) with OCT-A. Different BVN patterns such as seafan, medusa, and tangle were shown, and they are anatomically located between the RPE and BM, which were clearer than ICGA.[4] In another study, polyps were poorly resolved on en face images from OCT-A, but flow signal was clearly defined on cross-sectional OCT-A in 7 eyes.[5] Therefore, a combination of en face and cross-sectional OCT-A images provides complementary anatomical information about PCV

lesion components. In a study which compared swept source OCT-A (SS-OCT-A) with conventional angiography, flow signal with a vascular network configuration was detected in 42/54 eyes (77.8%) using OCT-A, which closely correlated with ICGA findings in terms of location and shape.[6] However, flow signals within polyps was only detected in 21/54 eyes (38.9%). The appearance of polyps on OCT-A was also variable, with some lesions appearing as hyperflow round lesions while others appear as round lesions with bright outline but dark lumen. The variation in flow signal within the polyp has been suggested to result from differences in blood flow characteristics, including turbulence and speed, within the polyp. Compared to ICGA, OCT-A detected hyperflow signal in only 40.4% of polyps. Therefore the authors concluded that OCT-A cannot totally replace the ICGA in PCV diagnosis.[6] Other challenges in interpreting OCT-A include limited field of view, which makes it difficult to delineate entire neovascular lesions. In addition, pigment epithelial detachments (PEDs), blood, extensive edema, and exudation, which are common in PCV, may lead to failure of segmentation or masking of flow signals on en face images.[1] Understanding of types and sources of artifacts such as motion artifacts (blinking or saccadic eye movements), segmentation artifacts (altered retinal architecture), projection artifacts (RPE, hard exudates, subretinal fibrosis), and masking artifacts is also important to ensure accurate interpretation of OCT-A.[1]

OCT-A has also been used to monitor changes within the PCV complex following treatment.[1,7] In one study which evaluated treatment-naïve eyes with PCV three months following treatment, reduced flow signal within PCV complex was more commonly seen in eyes following combination therapy of anti-vascular endothelial growth factor (anti-VEGF) and photodynamic therapy (PDT) compared to eyes treated with anti-VEGF monotherapy (84.6% vs 40.0%).[7] Pachyvessel caliber reduction was noted more commonly after combination therapy compared to anti-VEGF monotherapy (75.0% vs 0.0%, p=0.01).[7] Based on this study, OCT-A is useful in evaluating morphological outcomes and may reduce the need for repeat ICGA after treatment for PCV. However, the authors also emphasized the importance of evaluating the longitudinal changes on OCT-A in conjunction with structural OCT.[7] Figure 2 shows an example of significant reduction in flow within the polyp after monotherapy with Aflibercept.

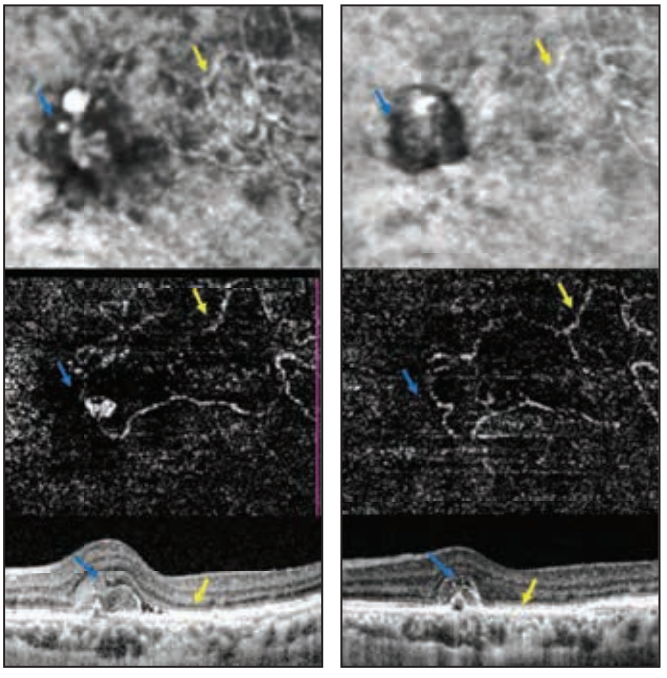

Figure 2 Comparison of images before (left column) and after (right column) aflibercept monotherapy in a 65 year old female with PCV. The string of polyps (blue arrow) has almost completely regressed on both ICGA (Top row) and OCT-A (middle row) after treatment, with corresponding reduction of subretinal fluid and hyperreflective material on cross-sectional OCT (bottom row). There is no obvious change in the branching vascular network (yellow arrow).

Another area of application for OCT-A in CNV and PCV is detection of non-exudative neovascularization (Figure 3).[8,9] The prevalence of non-exudative neovascularization is unclear, but previous studies have reported as ranging between 11-27% in white patients. In one study, 3 out of 11 (27.2%) patients with neovascular AMD in one eye and asymptomatic presumed intermediate AMD in the fellow eye were found to have neovascularization based on ICGA and OCT-A but absence of fluid on OCT.[8] En Face OCT-A images from outer retina to choriocapillaris layer detected flow signals which correspond to the plaques seen on ICGA in these 3 eyes.[8] In another study of 76 Asian eyes with unilateral exudative AMD (33 had AMD and 43 had PCV), 14 (18%) fellow eyes had non-exudative neovascularization detected either by ICGA alone (7/14 eyes, 50%), OCT-A alone (4/14, 29%) or combination of both (3/14, 21.4%).[9] At present, the clinical significance of these non-exudative neovascularization remains unclear. There is no current evidence to suggest a benefit in commencing treatment with anti-VEGF in these eyes. However, close follow-up is recommended for these patients.

Overall, OCT-A is a novel diagnostic tool which may have application in the diagnosis and monitoring for PCV. It can visualize both BVN and polyps in many eyes, and may provide

further insight on the effects of treatment (anti-VEGF and/or PDT) on the PCV complex as well as choriocapillaries and pachyvessels. OCT-A can also identify the presence of both exudative and non-exudative neovascularization and allow these patients to be monitored more closely. As the OCT-A software and hardware continue to improve, and clinical experience with this novel imaging modality accumulates, the utility of OCT-A in PCV is expected to increase further.

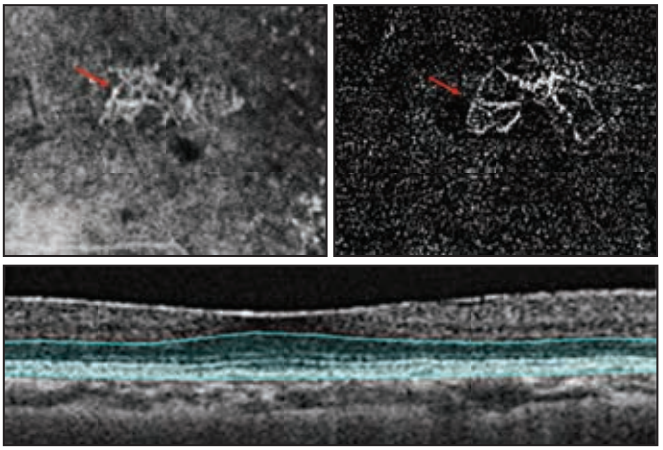

Figure 3. 65 year old female with non-exudative neovascularization (red arrow) detected on ICGA (top left) and OCTA (top right). The corresponding OCT (bottom) and outer retina segmentation (blue shade) used for OCT-A demonstrates the absence of intraretinal or subretinal fluid.

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OCT Angiography in uveitis – Q and A's

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As we are moving towards dye less angiography, how will OCTA replace FFA and ICG in our uveitis practice?

This is the trick question that everybody is asking Retina and Uveitis specialists all over the world. But indeed, the answer is quite simple. Do I think that chopsticks will ever replace forks? No, of course not. Chopsticks are incredibly fun to use in certain situations, but they would not get every one of us through a full meal. For this reason, in most upscale Chinese restaurants beside your chopsticks you find the comfort of a fork, an instrument that we are all familiar with and that we all are able to use. Same principle applies to OCTA: it should not be thought of as a machine built to replace dye tests, but as an implement to them.

The secret for a uveitis specialist is not to become great at interpreting OCTA, but to learn how to implement it into everyday practice-multimodal imaging. Because this is where OCTA can expand our knowledge of diseases.

For instance, employed together with ICGA, it has taught us that the choriocapillaris and choroid are not involved in MEWDS and that the hypofluorescence seen in ICGA has to be interpreted as RPE mottling that is not physiologically catching the ICG molecule. OCTA comparison to ICGA has confirmed the true choroidal nature of other diseases such as APMPPE, RPC and SLC.

In the field of uveitis in particular, OCTA shows all its weaknesses when compared to FA because of its inability to detect leakage. But it implements FA when it comes to differentiating outer retinal inflammatory material from inflammatory CNV.

No uveitis practice would survive with OCTA alone, as most meals would become interminable if eaten with chopsticks alone. But, as chopstick, learning the secret of OCTA can be extremely rewarding and fun.

OCTA interpretation is still evolving and very difficult. Is there any classification on OCTA, such as "hypo" or "hyper" lesions as defined on FFA and ICG in uveitis patients?

When interpreting OCTA lesions, the simplest way is to classify them in "high-flow lesions" and "low-flow lesions". High flow lesions are of particular interest to Retina Specialists since they consist mainly of choroidal neovascular membranes (CNV). For Uveitis Specialists, differentiating inflammatory CNVs from avascular chorioretinal inflammatory lesions is becoming easier with the advent of OCTA, since on traditional FA both lesions may leak and thus be masked.

When dealing with uveitis, low-flow lesions are very important as well. In a patient with retina vasculitis, I always look at the flow density color map of the superficial and deep capillary plexus. Two major studies have detected a decrease in the flow and the capillary density of the superficial plexus in 54 patients with retinal vasculitis. This does not necessarily mean vascular obliteration. In fact, the decorrelation signal of OCTA is not proportional to the flow velocity and OCTA does not enable detecting retinal capillary flow outside the range of 0.3 mm/second to 2 mm/second. It is therefore reasonable to assume that in patients with active vasculitis the leakage of plasma outside the inflamed wall contributes to a decrease in the flow velocity inside the retinal vessels. Fascinating how OCTA that has the disadvantage over FA of not being able to detect leakage, may in the future help us detect vasculitis in a dye-free way.

Low-flow lesions in the choriocapillaris are also incredibly fascinating to study with OCTA and they are giving us new insights into the pathogenesis and follow up of various diseases. In placoid diseases such as APMPPE, relentless and persistent placoid, these "hyporeflective" areas of low-flow in the

choriocapillaris co-localize with the hypofluorescence seen on ICGA, thus confirming the true ischemic nature of these lesions. Same concept applies for TB SLC, in which the low-flow areas of choriocapillaritis have preserved islands of choriocapillaris compatible with skip-lesions.

Uveitis patients need systemic treatment and regular follow up. The treatment needs to be changed depending on the response to treatment based on clinical and investigational tools such as FFA, ICG and EDI-OCT. Can OCTA quantify the posterior segment inflammation to help us manage uveitis patients?

No. Or better, not in an objective way and not yet. But objective quantification is not possible so far neither with FA nor with ICGA. Various groups are working on algorithm for automated analysis of leakage on FA, but, so far, our assessment of improvement of vascular leakage or decrease in the number of hypocyanescent dots on ICGA is very subjective. This lack of objective markers of disease activity is one of the greatest challenges in caring for patients with uveitis. And it is not simply limited to routine clinical practice (to direct treatment), but also affects clinical trials (to establish efficacy of new therapies and standardization of care). Different OCTA machines have built-in software that automatically calculates non-flow areas in superficial angiography images. These consist of color perfusion maps in which bright red represents a density of greater than 50% perfused vessels, dark blue represents no perfused vessels, and intermediate perfusion densities are color coded accordingly. However, the results of the vessels density from different machines are not comparable, so specialists all over the world recur to the trick of skeletonizing the OCTA image with ImageJ and measuring the 1 pixel vessels density with photographic software as GIMP.

An important clinical application of OCTA is its ability to noninvasively visualize the extension and morphology of CNVs. A second software available in most OCTA machines offers the "Flow Area" function that measure the CNV lesion size on OCTA. However, these measurements have low reproducibility in between different machines, and the flow area measurements do not correlate well with FA and ICGA measurements. Projection artifact is a major limitation of this technology, making it sometimes difficult to distinguish normal physiological vessels from pathologic ones. The software does provide a "remove artifacts" function, which can subtract projection artifact from superficial vessels, but this also causes some loss of signal of pathologic blood vessels. Also, not all neovascular complexes are visualized because of imprecision in slab segmentation, which requires careful control of the depth and thickness of the slab to more precisely identify the neovascular membrane.

My personal opinion is that the various companies that produce OCTA will have a hard time standardizing quantification of vessels flow or density (same as it happened for central retinal thickness in SD-OCT), so it will be up to us to develop systems to analyze and quantify the information provided by OCTA.

Uveitis is marred with media opacities, how will OCTA take care of these as one is looking for abnormalities in deeper vessels of the retina and choriocapilleries?

Every imaging modality suffers loss of signal with media opacities. Dense uveitis cataracts or diffuse vitreous hemorrhages cause a global loss of signal while focal opacities such a posterior subcapsular cataract or a band keratopathy can cause a local loss of signal behind the opacity. Prominent vitreous floaters from inflammation can obscure visualization of the retina and choroid, while subretinal hemorrhages can obscure visualization of the choroid. With large signal attenuation from whatever cause, it is more difficult to know if flow is present or not in the affected region. When it comes to OCTA, there are two wavelengths used to generate flow images. Spectral domain (SD) OCTA uses wavelengths near 800 nm while swept source (SS) OCTA uses light sources slightly longer than 1000 nm. The longer wavelengths penetrate tissue somewhat better. SS-OCTA is our best hope to avoid signal loss from media opacities. What we need are studies comparing these two modalities to determine which method penetrates better through media opacities, although theoretically SS-OCT should have fewer problems.

FAF can come up as non-interventional tool for managing various uveitic conditions. Will OCTA be able to replace FAF, or we still have to rely on multimodal imaging?

OCTA will never be able to replace FAF for the simple reason that while OCTA provides information on vascular flow, FAF provides a different set of information that relates to the health of the RPE. A breakthrough for Uveitis specialists was the discovery that RPE autofluorescence could be used as a marker for some inflammatory diseases activity. In such cases, abnormally high levels of FAF are thought to be due to the RPE being subjected to an abnormal metabolic load from inflammation.

It is the case of acute zonal occult outer retinopathy (AZOOR), a challenging disease that causes visual impairment due to

progressive photoreceptor loss. The RPE is sequentially affected following the death of photoreceptors cells. In FAF images, hyperautofluorescence at the border of the expanding lesion is presumed to result from accumulated lipofuscin in RPE cells due metabolic RPE over-activity related to photoreceptor outer segment turnover. FAF also highlights the subtle activity within the serpiginous choroiditis (SC) or tubercular serpiginous-like choroiditis (SLC) lesions, which may be missed on clinical examination. In the acute stage, the lesions show an ill-defined halo of hyperautofluorescence, in the presence of an increased metabolic activity of the RPE.

OCTA does not have this ability to detect increase metabolic load to the RPE secondary to inflammation.

However, there are some very fascinating theories on how we could compare the information provided by FAF on inflammatory activity with OCTA. The outer retinal neurons, including the photoreceptors, are physiologically maintained by the diffusion of oxygen from the choriocapillaris (80%) and from the deep retinal capillary plexus (20%). In animal models, retinal degenerations leading to loss of photoreceptors has been associated with the disproportionate diffusion of oxygen (from the choroid and deep retinal plexus) to the middle and inner retina, causing oxidative damage. As such, a future application of OCTA could be to study the deep capillary plexus and the choriocapillaris at the border of the active/inactive AZOOR, SC or SLC lesions (as distinguished by FAF). OCTA should theoretically show an increase in the deep flow at the level of the hyperautofluorescent lesions, which could also be associated with dilation of the arterioles that are releasing chemical mediators in response to the outer retinal inflammation.

In fact, a correspondence between the hyperautofluorescence surrounding active lesions and hyperreflectivity on OCTA at the level of choriocapillaris has already been described in SLC. It has been speculated that hyperreflectivity on OCTA could be related to increased vascular flow that corresponds to increased metabolic activity of the RPE seen as hyperFAF.

Future studies are needed to confirm this application of OCTA, but these observations are certainly food for thoughts.

Finally, what is the clinical utility of OCTA in your day-to-day uveitis practice?

Currently, every patient that comes to my Uveitis clinic undergoes a 3x3 mm and a 6x6 mm OCTA of the retina and choroid. If it's a patient with multifocal choroiditis or punctate inner choroidopathy, I study the outer retina and choriocapillaris through OCTA looking for inflammatory CNVs. If present, I follow their response to treatment with this dye-free modality. For placoid diseases, I look at the choriocapillaris areas of slow-flow on OCTA and compare them with other imaging modalities, and look for changes with treatment. Granulomatous diseases of the choroid such as sarcoid or TB can also be followed with OCTA: when the choroidal granulomas are bigger than a choroid lobule, they cause perfusion disruption which can be detected and followed through OCTA.

I am still reluctant to take clinical decisions for a uveitis patient simply based on OCTA, with all its limitations and artifacts. However, I always try to spend some time after Clinic reviewing the scans and looking at different cuts or flow densities: some very important information can be gathered.

Additionaly, in patients with anterior uveitis we perform a 6x6 OCTA scan of the whole iris with a focus increased to 28D; the iris is the primary site of inflammation in anterior uveitis, and an increase in the iris vessels flow can be detected with OCTA. With the advent of new softwares to measure vascular volumes, and with new OCTA machines equipped with an "anterior segment" module, analyzing iris vasculature can become an objective and non-invasive way of measuring acute iritis.

Finally, in patients with scleritis or episcleritis, I try to get an OCTA of the inflamed sclera. This is a bit more difficult than for the iris due to the curvature of the eye and the slow vascular flow. Buti t can be promising and it goes together with my philosophy in Uveitis imaging: every inflamed vessel can and should be imaged, and now we have a dye-free way to do this and we should try.

So, you want to buy an Angio OCT?

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Optical coherence tomography was the holy grail for retinal surgeons. At the time of its launch, the capability of this discovery was astounding and seemed to be the answer to many of our problems. The OCT is now a tool for every ophthalmologist on a daily basis. Yet there were those who doubted and some even went so far as to say that it would not really lead to any change in our diagnosis or patient management and was an academic tool.

Much the same is being said of OCTs new avatar, the Angio OCT. This technology is the new kid on the block and many of these questions are being asked of it. So, is it the machine for you? That depends on the situation of each person's practice. It is definitely not the tool for a general ophthalmology clinic like a conventional OCT, not as yet. It stands to reason, therefore that the main applicability of Angio OCT is for the vitreoretinal surgeon. Many of us already possess SD OCT machines and shifting to an Angio OCT platform involves both time and money. Both are precious commodities in today's world and many of us will ask a few basic questions

The first one is obvious "Should I buy an Angio OCT? How will it improve my outcomes and in how many patients?" I'm in a position where I can't answer that question because I don't have an OCT Angio Machine, but that positions me nicely to answer the next question, which is: If I wanted to buy one, which one would I buy?

OCT angiography machines are currently manufactured by Optovue, Zeiss, Topcon, Heidelberg and Nidek. To make a choice between them, it is necessary to know a little about their basic scanning philosophy as they all use different techniques to achieve the same goal. At a very basic level, OCT angio does with light wave what a Doppler machine does with sound. By a smart bit of mathematics, physics and computing, the machine is able to detect movement on or within the retinal tissue. This information is combined with B scans of a normal OCT and the movement is placed at a depth as well as a horizontal and vertical coordinate. This places the moving particle in space and multiple such scans build a map of movement in the retina. This is then brought to prominence by cancelling out all signals from static reflections. Since the only movement that occurs in the retina is within the retinal vessels, therefore the reassembled map of movement will trace out the blood vessels in the retina, resolved at depth on a tomographic map. The reassembly of this data allows reconstruction in a way that allows the operator to scroll through the various tomographic layers in the retina.

The mechanism by which each machine achieves this imaging is different for each manufacturer. In brief, the light beam returning from the retina to the detector in the machine has data that depict amplitude and phase. This information is used differently by each manufacturer. Some machines use only the amplitude information and some use both phase and amplitude. The Angiovue was the first commercially available machine in India and uses a detection algorithm called SSDA (Split Spectrum Decorrelation Algorithm). This uses half the spectrum of the reflected light in an attempt to detect decorrelation i.e. the signature response for a signal that depicts movement. The angiovue uses the amplitude information only. The Zeiss Angioplex on the other hand uses Both Amplitude and Phase in a concept that is termed OMAG. Apparently, this provides better resolution since two aspects of the data signal are used, thus improving the resolution. The Topcon DRI OCT uses a protocol called the ratio based analysis(OCTARA) that also uses both phase and amplitude components of the signal. The Heidelberg machine uses FSADA (Full spectrum Amplitude decorrelation algorithm) which differs from the SSADA used by Angiovue in that it uses the complete spectrum of Amplitude information.

Does this translate into usable information? Is there any way to be certain that one protocol is better than the other? Quantifying images and resolution beyond the numbers is always difficult. So the first criteria would be how clear is the image of the object of interest The next clarity related question is how tolerant is the machine to a media opacity? Besides this, clinic efficiency, user friendliness and patient friendliness need to be qualified.

One surgeon was kind enough to run a series of patients through three machines to assess the time required for an angio OCT scan on all three machines. These were the a) Zeiss angioplex on a Cirrus 6000 platform, b) Topcon Dri OCT Swept source and c) Heidelberg HRA angio OCT 2. The raw data for 14 patients on all three machines is reproduced in table 1. A quick look will show that patients tend to do well and machines tend to scan quickly if the media is clear like in young patients with good fixation. The devil however is in the elderly with not so good media and fixation. A quick glance at the table reveals that acquisition times in Patients aged more than 50 tend to be longer. Of course, there are many problems with this data but a general trend is noticed across machines. The Zeiss machine tends to do better in elderly eyes with the Topcon close behind. In young patients, the Topcon is marginally ahead. The Heidelberg has longer acquisition times in this trial, however it must be pointed out that this is a small data set. We have been unable to test the Nidek and Angiovue machines and that remains to be done at a later date. However, we were able to ask a Nidek user his views on the machine. Since he had also used the Zeiss angioplex, he was able to compare the two. He found the Zeiss was easier to use and had less artefacts since it procured scans faster.

Image clarity was a subjective assessment by the person conducting the trial and was reported as Zeiss better than Heidelberg, better than Topcon. Two other users have reported patient friendliness and clarity of image to be in the following order: Angiovue was better than Zeiss in ease of use but Zeiss better than Angiovue in clarity and had the least artefacts. Both were better than Topcon in these parameters according to these users. Again, these were subjective assessments but there is no objective way to assess these parameters in the real clinical situation. Processing times were not tested and are an important parameter not mentioned in the product brochures, so it would be advisable that prospective buyers test this during Demonstrations by the company. According to the Surgeon using the Nidek Machine, he felt the Nidek machine has excellent vascular detail and he ranked it better than the Zeiss Angioplex.

Image artefacts are a serious and bothersome issue in all OCT angio studies and in the clinic. All users consistently felt that the Zeiss machine had the least artefacts. We did not get reliable information on artefacts from the Heidelberg machine but the Topcon was close behind and the Angiovue lagged in this respect.

Each machine has some attractive features and users may decide that it tilts the scales for them in its favour. The Angiovue is easy to use. The Topcon has the best SD OCT since it is a swept source machine. It is also possible to capture fundus pictures, Fluorescein angiograms, Autofluorescence, SD OCT and Angio OCT in a manner that provides registered images. However, the facility for ICG is missing. The Zeiss Angioplex has an excellent SD OCT and Fundus Picture registered with the Angio OCT and some representatives have stated that in the future this can also be registered with microperimetry from the Humphrey visual field analyser via the Forum Software. The Heidelberg has the most versatile mix of Fundus imaging, Autofluorescence, FFA, ICG, SD OCT and AngioOCT. These modalities are available both in conventional and wide field modes. This makes it a very attractive multimodal imaging solution since all the lesions are registered and can be studied across all the imaging modalities. The Nidek has an auto Panorama mode that allows multiple scan to be stitched together in a mosaic, building up an OCT mosaic in a wide field. It also has the attractive option for overlaying microperimetry from a separate microperimetry machine and the facility to select the fovea as the centre in lesions located away from the posterior pole. The greatest drawbacks for the Nidek were the longer acquisition times and time required for stitching together the mosaic, which was significantly long. Processing times are approx. 30 seconds which seems to be similar in most machines. The choice for each user depends upon his particular practice situation and what parameters he considers useful. Almost all these machines have excellent Conventional SD OCT Bscan capabilities with the Topcon SS OCT obviously the best of the lot.

Topcon, Zeiss, Nidek and Heidelberg, all have software solutions for networking that enable images to be viewed remotely at the practitioners' desk. This may be an attractive add-on for multispecialty environments. However, users must beware that each viewing station requires a separate license that will need to be purchased. Users must also try out the software to ensure that it allows the doctor to view and scroll through video files of the scan. Some version of software allow viewing only PDF files and that is a serious disadvantage for an OCT viewer.

To conclude, there are five main players in the Angio OCT market and each has something to offer the viewer. Although their scanning protocols are marketed with great fanfare, the average user really cares little as long as the machine is reliable, does not fail to scan patients often and produces good quality scans as

quick as possible. Sadly, companies consistently fail to provide this information in their brochures and much of this data is not easily quantifiable. Therefore, though I reiterate that much of the information presented above is subjective, I do believe it may add to the decision matrix for a practitioner trying to decide on his choice of machine. It is hoped that this article provides some insight into the way forward for an average practitioner like me who is bewildered by all the jargon and marketing strategies.

Table 1 : Acquisition times tested for OCT Angio Machines

Serial	Sex	Age	Sequence	Laterality	Angiplex 5000	Topcon DRI OCT	Spectralis
1	m	28	A	OD	64	62	75
3	F	37	C	OS	47	40	171
11	M	43	B	OS	48	51	82
6	F	48	C	OS	54	50	105
13	M	51	A	OD	215	82	90
10	M	58	A	OD	44	41	71
14	M	60	B	OD	115	183	146
9	F	62	C	OD	60	64	95
4	M	64	A	OD	82	65	75
7	F	65	A	OS	195	104	98
8	M	65	B	OD	90	215	125
2	M	71	B	OD	341	360	476
12	F	76	C	OS	390	615	515
5	F	81	B	OS	225	311	280

Table 1 : Acquisition times for Three OCT Angio Machines (in Seconds)

Note: Sequence denotes the order in which the patients were tested.

A	Zeiss >Topcon>Spectralis
B	Topcon>Spectralis>Zeiss
C	Spectralis>Zeiss>Topcon

Acknowledgement: I must acknowledge the help of five practitioners without whom this article would not have been possible. For obvious reasons, they remain anonymous and they know who they are. I am grateful and indebted

Artifacts in OCT Angiography

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Abstract

OCT Angiography(OCTA) is a promising novel method for visualizing the microvasculature of retinal and choroidal vascular layers. It provides depth –resolved functional and structural information on blood flow in the vessels. OCTA is based on motion contrast principle. However, artifacts can arise from the OCT image acquisition, intrinsic characteristics of the eye, eye motion, image processing, and display strategies. There are a number of different algorithms available which have the potential to visualize flow, but all methods have the potential to have additional, undesirable image artifacts. The goal of this article is to provide a framework for the clinician to understand and recognize OCTA artifacts to reduce the risk of misinterpretation.

Keywords: OCT Angiography, Artifacts, En-face imaging

Introduction

Optical Coherence Tomography Angiography (OCTA) is an emerging tool for modern retinal imaging and is set to become an integral part of the management and diagnosis of numerous retinal diseases. OCTA uses motion contrast to image blood flow and thereby images the vasculature without the need for a contrast agent. It has the potential to generate images with higher contrast and resolution of the microvasculature than conventional Fluorescein angiography. OCTA visualizes vessels under the RPE and provides depth-resolved images. Although OCTA shows great promise, it must be interpreted along with knowledge of possible defects, deficiencies and imperfections in the acquired images. Unfortunately, even with the best imaging modality, the images are not perfect and there are extra or missing links of information or translation, called "artifacts".

Origins of Artifacts in OCT Angiography

Spaide et al[1] described the various image artifacts and these can have multiple causes ranging from technical to clinical factors. These include: 1) How OCT data is acquired and generated – Image acquisition; 2) the intrinsic properties of the eye; 3) eye movement and 4) image processing and display strategies.

Classification

Evaluation of image artifact is a critical aspect and failure to recognize and understand the underlying basis for image artifact may lead to incorrect diagnosis, errors in automated quantitative image analysis and thereby misleading conclusions. A classification system of this will facilitate the systematic approach to image interpretation and serve as a benchmark for image grading (Table 1) Chen et al[2] observed that increased OCTA signals were noted in projection, unmasking and stromal decorrelation artifacts whereas attenuated OCTA signals were noted in motion, fringe washout and masking decorrelation artifacts.

Table 1
Classification of OCTA artifacts

Movement Artifact
Decorrelation Projection Artifact
Masking and unmasking
Fringe washout
Stromal decorrelation

1. Movement artifact

Patient movements during the acquisition of OCTA scans create motion artifacts in the volumetric data that delays registration and analysis. Horizontally and vertically orientated dark or bright lines and bands will be seen in OCTA images due to motion artifacts.(Fig.1)

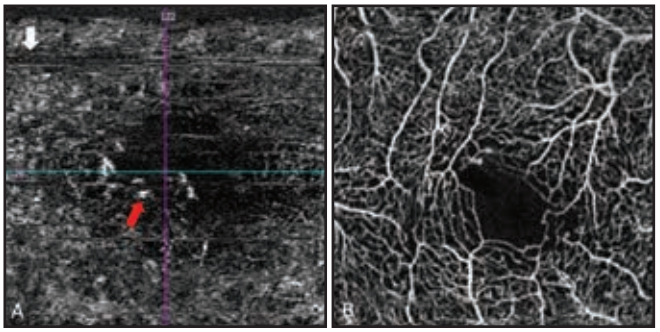

Fig 1: Angiographic demonstration of motion artifact. (A) Movement artifact shown by white arrow. Also few projection artifacts seen from overlying retinal vessels (red arrow) (B)Image without artifact: Normal OCT A

The OCT instrument creates a raster pattern while scanning a selected region of the eye. The scan takes a finite amount of time, and if the patient does not move, the image is produced with no artifact. During the scan, however, if the eye moves, a white line will be created at the intersection of the two images, suggesting that there is a loss of correlation.

Software-based motion correction works by estimating the eye motion. This software approach can compensate for some movement artifacts but can introduce artifacts of its own, such as

(a) Vessel doubling: A defect related to software correction of eye motion in which two copies of each blood vessel are seen in part or the entire image. (Fig 2 A)

(b) Displacement artifact: Caused by eye motion during a raster scan, where part of the image is from one region of the eye, whereas the remaining portion of the image is from a discontinuous region. (Fig 2 B)

(c) Stretching defects: Part of the image seems to have been stretched, much the same as if the image were printed on a rubber sheet. This may lead to discontinuity in the blood vessels. (Fig 2 C)

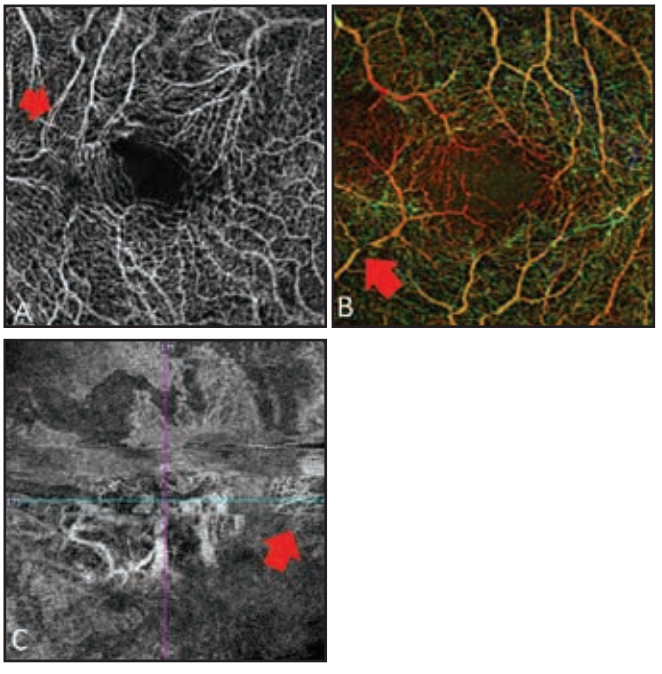

Fig 2: Angiographic Images showing (a) Vessel doubling(arrow) (b) Colour coded map showing Displacement artifact (arrow) (c) Stretch artifact(arrow)

2. Decorrelation projection artifacts

It is one of the most significant artifact influencing the assessment of OCTA. It is almost always present and seen in any structure that is located below vessels. The physiology behind it is that the light that has passed through the blood vessels changes over time, and so the reflection of this light is detected as having a decorrelation. Therefore, the retinal pigment epithelial layer (RPE) will seem to have blood vessels that have the pattern of the overlying retinal blood vessels. This effect is called as an "OCTA projection artifact".

Projection artifact can be seen at different slabs: Firstly, the vasculature of the deep retinal layer obtained by OCTA, also suffers from the projection artifacts from the superficial retinal layer (Fig 3 A& B). Second type of projection effect leads to "false" flow signal at places where it should otherwise have no flow signal at all. These are observed at the RPE tissue complex by considering the fact that this tissue complex is avascular (in normal subjects). As Examples are the edge of Pigment epithelial detachment (Fig 4A &C) and drusen with no choroidal neovascularization (CNVM) (Fig 4B&D). These produce images that seem to have vessels, creating a False positive decorrelation signal on the OCT A image.

Thirdly, image at the level of choriocapillaris is a source of confusion for example in a case of sub RPE choroidal neovascularisation. When the image plane is selected to be at the level of the RPE, the projection image from the retinal vessels is seen. If the section is moved deeper, small vessels will be seen connecting up to the choriocapillaris without the retinal vascular projection image. (Fig 5)

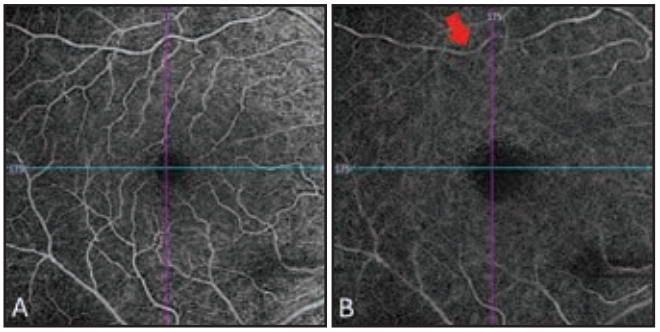

Fig 3: Image showing (A): Superficial retinal plexus (B) Deep retinal plexus showing projection artifact from superficial retinal layer (arrow)

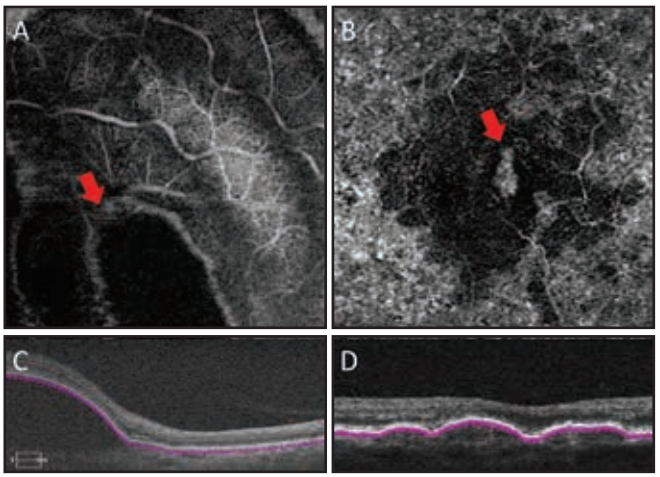

Fig:4 Image showing False positive decorrelation projection artifact from (A) Edge of Pigment Epithelial Detachment (B) Drusenoid Pigment epithelial detachment with no Choroidal neovascular membrane. (C)Bscan OCT showing large PED (D)Bscan OCT showing Drusenoid PEd

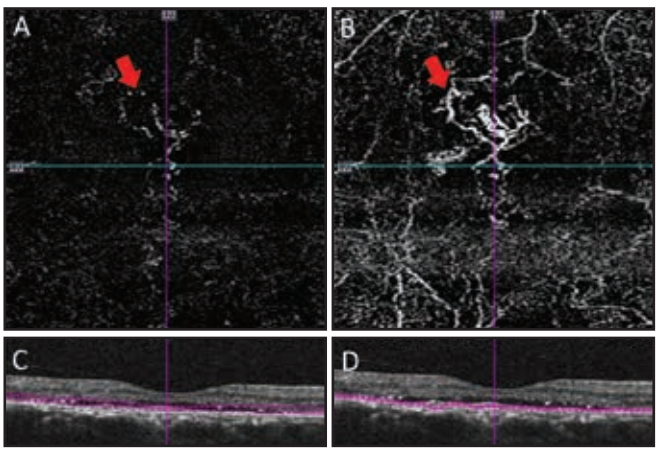

Fig 5 (A) Projection artifact from retinal vessels giving impression of flow at avascular slab.(B) After segmentation in the same image at sub RPE level vascular network seen without artifact suggestive of actual flow and choroidal neovascular membrane. Bottom images (C&D) showing corresponding Bscan OCT image indicating segmentation at both levels.

Practical approach of minimizing Projection artifacts

Amplitude/phase based and complex amplitude based algorithms software are all susceptible to projection artifacts. To minimize the effect of it is best to have manual segmentation along with automated segmentation in software. Also considering the Enface image and OCT structural information simultaneously helps to aid in minimization of the projection artifact.

Zhang Q[4] et al did a study on using SSOCTA and SDOCTA prototype based on OMAG algorithm and found that using removal of projection artifacts algorithm, there is improvement in the visualization and measurements of the neovascular lesions.

3. Masking and unmasking

The random fluctuations of noise, particularly in low signal regions, can create a false appearance of flow in atrophy of the RPE (Fig 6 A&C) and choriocapillaris, retinal edema and tissue infiltration. To reduce this a process called masking or thresholding may be used to only process OCTA from structures, which have a sufficiently strong signal, effectively deleting OCTA data from low signal or noisy structures.

Segmentation algorithms may fail in macular telangiectasia (MacTel) Type 2,5 and high myopic patients. When the segmentation algorithms fail from any cause, the layers of vessels are visualized together in ways that do not reflect actual anatomy and results in segmentation artifacts.

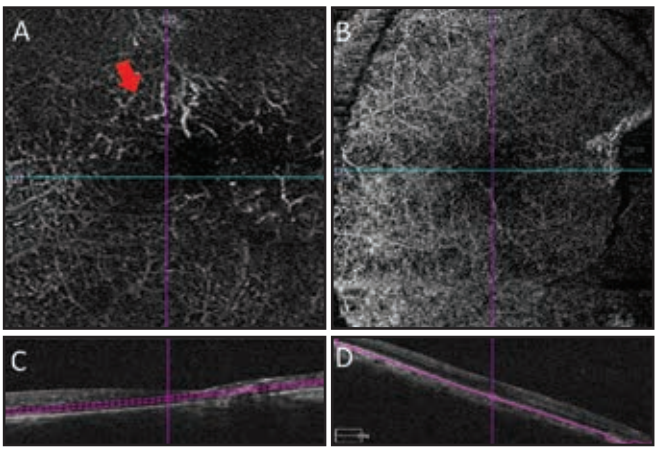

Fig 6: (A) OCT Angiographic image showing false appearance of flow (arrow) suggestive of artifact in RPE atrophy. (C) Corresponding OCT Bscan shows segmentation.

4. Fringe wash out artifact

This artifact is most commonly observed at choroid level especially in macular pathologies. The retinal blood flow generates high decorrelation signal in the superficial and middle

retinal layers, but blood flow within the small and large choroidal vessels generates poor backscattered signal because of fringe washout effect. Therefore, it is only possible to visualize the vessel outline in the choroid.

5. Stromal decorrelation artifact

Decorrelation signal is seen at the extravascular stroma of the choroid. These are more prominent in the Haller's layer where the signal void within the larger lumen provides a greater contrast with bright stromal signal. This is again mostly observed at choroid level.

Other artifacts

Media Opacity Artifact: Dense cataracts and diffuse vitreous hemorrhages causes global loss of signal, whereas focal opacities can cause a local loss of signal behind the opacity. Prominent vitreous floaters (Fig 7) can obscure visualization of the retina and choroid whereas subretinal hemorrhages can obscure visualization of the choroid. Prominent vitreous floaters may often lead to appearance of false flow void area in all the layers of the retina.

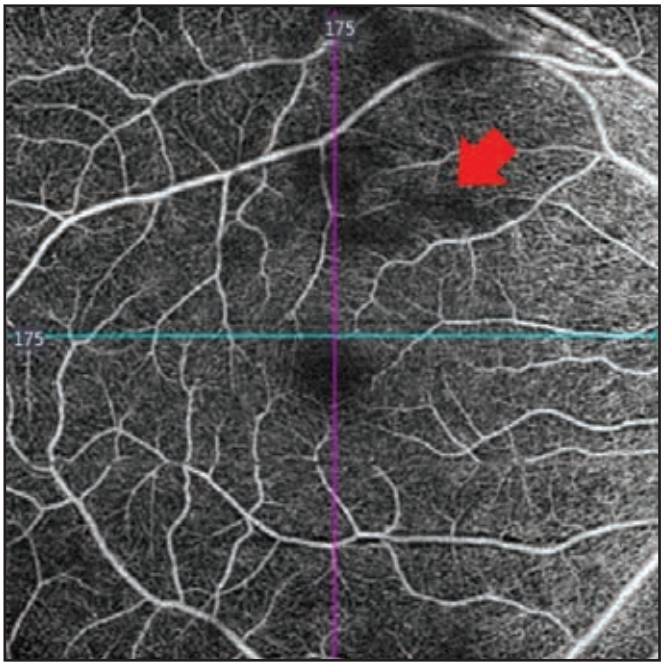

Fig 7: Artifact due to vitreous floater obscuring the view at superficial retinal plexus (arrow)

Conclusion

Combined viewing of structural OCT B-scans and en face images, along with the OCTA images should significantly reduce the risk of misinterpretation while providing more comprehensive information on retinal pathologic studies. The analysis and interpretation requires the clinician themselves to view the images as a video rather than to rely on a print-out given by a technician. It is also imperative to manually move the segmentation lines to trace the vessels individually and rule out artifacts. This could significantly reduce risk of artifacts and improve interpretation, especially in the context of complex pathologies or surgical planning. We require an increased understanding of the origins of OCTA artifacts and how they are manifested to overcome their shortcomings. One needs to perform an exhaustive and patient evaluation of the images at different slabs. Segmentation strategy and corresponding en-Face images are equally important. There are significant challenges remaining and new paradigms are needed to more accurately display and interpret OCTA information.

Reference

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6. Ghasemi Falavarjani K, Al-Sheikh M, Akil H, Sadda SR. Image artifacts in swept source optical coherence tomography angiography. Br J Ophthalmol. 2017; 101:564-8.

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List of Important Manuscripts on Optical Coherence Tomography Angiography by VRSI Members

Compiled by
Aniruddha Agarwal, MD
Ophthalmology (Vitreoretina and Uveitis)
Advanced Eye Center, PGIMER, Chandigarh (India)
Ocular Imaging Research and Reading Center (OIRRC), Menlo Park, CA (USA)
Truhlsen Eye Institute, UNMC, Omaha (USA)
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1. Swept source optical coherence tomography-angiography of choroid in choroidal hemangioma before and after laser photocoagulation. Chawla R, Tripathy K, Sharma A, Vohra R. Indian J Ophthalmol. 2017 Aug;65(8):751-754.

In this manuscript, the authors describe the unique role of OCTA characteristics of circumscribed choroidal hemangioma before and after laser photocoagulation, aiding in the recognition of vascular changes in choroid due to choroidal tumors and their response to therapy.

2. OCT angiography demonstrates retinal angiomatous proliferation and chorioretinal anastomosis of type 3 neovascularization. Bansal R, Hemanth V, Mulkutkar S, Singh R, Gupta V, Dogra MR, Gupta A. Int Ophthalmol. 2017 Aug 1.

This case report highlights the utility of OCTA in making a quick diagnosis of type 3 neovascularization by demonstrating a supranormal flow within the lesion.

3. Optical coherence tomography angiography characterisation of Best disease and associated choroidal neovascularisation. Guduru A, Gupta A, Tyagi M, Jalali S, Chhablani J. Br J Ophthalmol. 2017 Aug 1. Pii: bjophthalmol-2017-310586

The authors demonstrate that OCTA is superior to fluorescein angiography in determining abnormalities in Best disease, including detection of abnormal FAZ, patchy vascularity loss in the superficial and deep layers of the retina and capillary dropout with a hyporeflective center in choriocapillaris.

4. In Vivo Microvascular Pattern of Solitary Juxtapapillary Capillary Hemangioma on OCT Angiography. Thirumalesh MB, Jain A, Agrawal S, Bhujang Shetty K. Ophthalmic Surg Lasers Imaging Retina. 2017 Jul 1;48(7):592-595.

In this case report, authors describe the role of OCTA in helping the study of the intrinsic vascularity of the tumor and differentiation from other vascular tumors.

5. The application of optical coherence tomography angiography in uveitis and inflammatory eye diseases. Pichi F, Sarraf D, Arepalli S, Lowder CY, Cunningham ET Jr, Neri P, Albini TA, Gupta V, Baynes K, Srivastava SK. Prog Retin Eye Res. 2017 Jul;59:178-201.

This is an excellent review on OCTA and its role in imaging, management and prognosis of uveitis diseases.

6. Evaluation of macular and peripapillary vessel flow density in eyes with no known pathology using optical coherence tomography angiography. Hassan M, Sadiq MA, Halim MS, Afridi R, Soliman MK, Sarwar S, Agarwal A, Do DV, Nguyen QD, Sepah YJ. Int J Retina Vitreous. 2017 Jul 31;3:27.

This is one of the first manuscripts to describe the vessel density in macular and peripapillary regions in normal population. Vessels in the parafoveal region are more densely packed in the deep retinal plexus leading to higher vessel density compared to superficial plexus.

7. Distinguishing features of acute Vogt-Koyanagi-Harada disease and acute central serous chorioretinopathy on optical coherence tomography angiography and en face optical coherence tomography imaging. Aggarwal K, Agarwal A,

Deokar A, Mahajan S, Singh R, Bansal R, Sharma A, Dogra MR, Gupta V; OCTA Study Group. J Ophthalmic Inflamm Infect. 2017 Dec;7(1):3.

In this prospective study, the authors demonstrate the differences in the choroidal vascular anatomy among patients with VKH disease and CSC. Patients with CSC do not have choriocapillaris flow void areas, which are seen among patients with VKH disease.

8. En face optical coherence tomography and optical coherence tomography angiography of multiple evanescent white dot syndrome: New Insights Into Pathogenesis. Pichi F, Srivastava SK, Chexal S, Lembo A, Lima LH, Neri P, Saitta A, Chhablani J, Albini TA, Nucci P, Freund KB, Chung H, Lowder CY, Sarraf D. Retina. 2016 Dec;36 Suppl 1:S178-S188.

In this study, the authors demonstrate the choroidal vascular anatomical alterations in patients with MEWDS and their temporal changes.

9. Morphological differences between optic disc collaterals and neovascularization on optical coherence tomography angiography. Singh A, Agarwal A, Mahajan S, Karkhur S, Singh R, Bansal R, Dogra MR, Gupta V. Graefes Arch Clin Exp Ophthalmol. 2017 Apr;255(4):753-759..

The authors show that OCTA provides improved visualization of NVDs and optic disc collaterals in ischemic retinal diseases such as diabetic retinopathy and retinal vein occlusions compared to conventional angiography.

10. Novel findings on optical coherence tomography angiography in patients with tubercular serpiginous-like choroiditis. Mandadi SKR, Agarwal A, Aggarwal K, Moharana B, Singh R, Sharma A, Bansal R, Dogra MR, Gupta V; for OCTA Study Group. Retina. 2017 Sep;37(9):1647-1659.

In this first of its kind study, the authors conclude that OCTA provides high-resolution structural information of the retinochoroidal vasculature in tubercular serpiginous-like choroiditis. Morphologic information obtained from OCTA images correlates well with and supplements other imaging techniques such as indocyanine green angiography and enhanced-depth imaging OCT, such as areas of choriocapillaris hypoperfusion.

11. Optical Coherence Tomography Angiography Features of Paradoxical Worsening in Tubercular Multifocal Serpiginoid Choroiditis. Agarwal A, Aggarwal K, Deokar A, Mandadi SK, Singh SR, Singh R, Sharma A, Bansal R, Gupta V; OCTA Study Group. Ocul Immunol Inflamm. 2016 Dec;24(6):621-630.

Paradoxical worsening is a potential vision-threatening sequelae following treatment with anti-tubercular therapy. OCTA provides high-resolution imaging of progressive choriocapillaris hypoperfusion among tubercular uveitis patients developing worsening of the disease.

12. The Role of Optical Coherence Tomography Angiography in the Diagnosis and Management of Acute Vogt-Koyanagi-Harada Disease. Aggarwal K, Agarwal A, Mahajan S, Invernizzi A, Mandadi SK, Singh R, Bansal R, Dogra MR, Gupta V; OCTA Study Group. Ocul Immunol Inflamm. 2016 Jul 20:1-12.

This is one of the landmark studies in the management of VKH disease. The authors show presence of inflammatory foci suggestive of choriocapillaris hypoperfusion in acute VKH disease using OCTA non-invasively. OCTA may be very helpful in the follow-up of such patients.

13. Swept source: optical coherence tomography angiography features of choroidal osteoma with choroidal neovascular membrane. Azad SV, Takkar B, Venkatesh P, Kumar A. BMJ Case Rep. 2016 Jun 2;2016. Pii: bcr2016215899.

This is a case report showing development of choroidal neovascular membrane in a case of choroidal osteoma imaged using OCTA.

14. Optical coherence tomography angiography: a non-invasive tool to image end-arterial system. Agrawal R, Xin W, Keane PA, Chhablani J, Agarwal A. Expert Rev Med Devices. 2016 Jun;13(6):519-21.

This is an introductory review of the technology of OCTA and the various devices and algorithms available to perform OCTA.

15. Monitoring neovascularization in aggressive posterior retinopathy of prematurity using optical coherence tomography angiography. Vinekar A, Chidambara L, Jayadev C,

Sivakumar M, Webers CA, Shetty B. J AAPOS. 2016 Jun;20(3):271-4.

This is an interesting case report describing the use of optical coherence tomography angiography (OCTA) in detecting and monitoring regression of the neovascular complex (NVC) in a case of aggressive posterior retinopathy of prematurity (AP-ROP). En face spectral domain optical coherence tomography (SD-OCT) and OCTA, the NVC appeared as an arborizing vascular net in the superficial capillary plexus. The deep capillary plexus and outer retinal layers showed corresponding flow outlines that suggested deeper extensions of the lesion.

16. Characteristics and quantification of vascular changes in macular telangiectasia type 2 on optical coherence tomography angiography. Chidambara L, Gadde SG, Yadav NK, Jayadev C, Bhanushali D, Appaji AM, Akkali M, Khurana A, Shetty R. Br J Ophthalmol. 2016 Nov;100(11):1482-1488.

In this manuscript, the authors used OCTA in improving our understanding of the complex pathological changes and changes in the blood vessels across different layers in patients with macular telangiectasia. The authors found increase in the intervascular spaces with progressive capillary rarefaction and abnormal capillary anastomosis. The outer retina and choroid were involved during the later stages and showed a prominent vascular network.

17. Spectral Domain Optical Coherence Tomography Angiography Features in a Patient of Central Retinal Arterial Occlusion Before and After Paracentesis. Bhanushali DR, Yadav NK, Dabir S, Chidambara L, Srinivasan P, Shetty R. Retina. 2016 May;36(5):e36-8.

In this case report, changes in the central retinal vascularity following paracentesis for central retinal arteriolar occlusion has been described.

18. Analysis of Retinochoroidal Vasculature in Human Immunodeficiency Virus Infection Using Spectral-Domain OCT Angiography. Agarwal A, Invernizzi A, Acquistapace A, Riva A, Agrawal R, Jain S, Aggarwal K, Gupta V, Dogra MR, Singh R. Ophthalmology Retina [in press] DOI: ***http://dx.doi.org/10.1016/j.oret.2017.03.007.***

This is one of the first reports of the use of OCTA among patients with HIV. Among patients with HIV, there was evidence of retinal vascular telangiectasia, capillary loops, and increased intercapillary spacing compared to healthy controls. Foveal avascular zone area was abnormally enlarged among patients with HIV compared with healthy controls. Eyes without clinical or angiographic evidence of retinopathy demonstrated retinal vascular telangiectasia and increased intercapillary spacing on OCTA.

PROCEEDINGS OF THE MID-TERM VRSI RETINAL IMAGING SYMPOSIUM IN THE HIMALAYAS (RISHI)-II 2017

Venue: Rotary Eye Hospital Auditorium, Palampur, HP, India
Dates: 16 – 17th June 2017

Conference Coordinators

Organizing Secretaries : Dr. Sudhir Salhotra and Dr. Ramandeep Singh

Organizing Chairmen : Dr. S.K. Sharma and Dr. Mangat Ram Dogra

Program Coordinators : Dr. Vishali Gupta and Dr. SriniVas Sadda

The Mid-term VRSI and RISHI-II was conducted with much success with a number of renowned international and national faculty and ophthalmologists, residents, and fellows from various centers of the country.

Notable International Faculty: SriniVas Sadda, Rupesh Agrawal, Gemmy Cheung, Francesco Pichi, Andre Romano, Adnan Tufail

The aim of the conference was to understand the breadth of Retinal Imaging in the present era and propose various novel innovations in order to improve our understanding of various vitreoretinal pathologies. The experts provided various insights in to the field of retinal image analysis and summaries of Deep Learning and Machine Learning.

Given the success of RISHI-I held at Timber Trail Heights, Parwanoo, international retina and uveitis experts gathered at Palampur in June 2017 to showcase their latest research in retinal imaging including their best cases from across the globe. More than 150 delegates attended the conference which was highly interactive in nature. The conference focused on several topics in retinal imaging, such as optical coherence tomography (OCT), OCT angiography, fluorescein angiography, indocyanine green angiography and swept-source imaging. Dr. Cheung and Dr. Giridhar presented interesting findings on OCT angiography, swept-source imaging, OCT and contrast angiography in polypoidal choroidal vasculopathy. Dr. Tufail and Dr. Sadda presented interesting perspectives on deep learning and their potential role in diabetic retinopathy screening programs. RISHI-II also highlighted advances in choroidal imaging, including studies on choroidal vascularity by Dr. Rupesh. In the field of uveitis, multimodal imaging perspectives in white dot syndromes was presented by Dr. Pichi.

The delegates enjoyed an academic feast with multiple interactive sessions and case discussions. There were several challenging case discussions from prominent eye centers from our country and abroad. The presenters were given unique insights by the attending delegates and the panel of experts who critically analyzed each case. Some of the challenging cases presented were posterior scleritis, ocular lymphoma, choroidal granulomas and bestrophinopathy.

Overall, Palampur was a picturesque destination with several sight-seeing and historical places of interest. The host faculty was very hospitable and the city was welcoming. As Dr. Giridhar, Dr. Natarajan, Dr. Raja Narayanan and Dr. Ajit Babu Majji concluded, Mid-Term VRSI should be a regular feature of VRSI, and RISHI-II was a grand success.





Welcome to

VRSI 2017

30th November to 3rd December

Mayfair Convention Center, Bhubaneswar

Invitation

The freshness in the air, the sweetness in the dialect and the warmth in our hospitality is awaiting you in this young and vibrant city recognised lately as the smartest city of India. It is our proud privilege to host the 26th Annual Meeting of Vitreo-Retinal Society of India at Mayfair Convention Centre, Bhubaneswar under the aegis of Odisha State Ophthalmological Society. With the objective of treating to the latest developments in the vitreoretinal practice patterns we welcome you to a scientific gala that is likely to be as fresh and invigorating as the surrounding natural beauty of our grand city. With a galaxy of international and national faculties to add their wizardry to the scientific deliberations the conference is bound to be scintillating.

Basking in the bright sunshine of early December with a pleasant nip in the air, the city and its neighbouring satellite towns attract not only tourists from all across the globe but also flocks of migratory birds to its scenic seaside water reservoirs. Around the same time the ancient relics of the state would be coming alive with their annual cultural festivals and the Odiya cuisine would be at its seasonal and gastronomical best. We sincerely hope that you and your family will have umpteen reasons to indulge your brain and your senses. Welcome to the grand feast of VRSI - 2017 at Bhubaneswar.

Dr S T Muralidhar
Chairman, Organizing Committee

Dr Santosh Kumar Mahapatra
Organizing Secretary

LOCAL ORGANIZING COMMITTEE

Prof Dr K C Padhy Chief - Patron	**Dr S T Murlidhar** Chairman, Organizing Committee	**Prof Dr B N R Subudhi** Chairman, Reception Committee
Dr Santosh Ku. Mahapatra Organizing Secretary	**Dr Umesh Behera** Co-Organizing Secretary	**Dr Siddhartha Das** Treasurer
Dr P K Sharma Member, Executive Committee	**Dr S Basu** Member, Executive Committee	**Dr Tapas Ranjan Padhi** Member, Executive Committee
Dr Sanghamitra Kanungo Member, Executive Committee	**Dr G N Rao** Member, Executive Committee	**Dr Subhabrata Parida** Member, Executive Committee
Dr B K Mohanty Advisor	**Dr P K Verma** Advisor	**Dr Ashok Nanda** Advisor

From President's Desk

Dear Members,

Greetings from the Vitreo Retinal Society-India !

The **XXVIth** Annual Meeting of the **Vitreo Retinal Society-India** will be held in **Bhubaneswar** from **30th November** to **3rd December**, 2017 at the **Mayfair Convention Centre**. We as members of the Governing Council had recently visited Bhubaneswar and the facilities available have been examined for conducting of a memorable conference. The organizing committee, under the leadership of Dr Santhosh Kumar Mahapatra, is very enthusiastic and I am sure that under the collective leadership of all the members of the organizing committee, we would be having a wonderful meeting.

It is for 3rd time in the history of the Society that the annual meeting is being held in the eastern part of the country. Bhubaneswar, at present, is well connected to all the major cities in India and therefore delegates will not have any difficulty in planning their journey to Bhubaneswar to participate in this meeting. The organizing committee also has plans to organize a visit to the famous Jagannath temple in Puri and also a visit to Konark.

Dr Raja Narayanan, our Honorary Secretary and Dr Vishali Gupta, our Convener of the scientific program, are in the process of finalizing a very innovative scientific program. I therefore request all members to mark the calendar and participate in this very important meeting of the Vitreo Retina Society.

With best wishes

Dr A Giridhar, President, VRSI

GOVERNING COUNCIL VRSI

President	Vice-President	Honorary Secretary	Convenor Scientific Committee
Dr A Giridhar	**Dr Shobit Chawla**	**Dr Raja Narayanan**	**Dr Vishali Gupta**

Jt. Secretary	Treasurer	Joint Treasurer	Member, Executive Committee
Dr Manisha Agarwal	**Dr Hemanth Murthy**	**Dr Prashant Bawankule**	**Dr Thomas Cherian**

Member, Executive Committee	Member, Executive Committee	Ex-Officio
Dr Ramandeep Singh	**Dr Anand Rajendran**	**Dr Ajit Babu Majji**

Conference Highlights

- Pre Conference wet Lab at LVPEI.
- Participation by International Societies.
- The Natraja Pillai Oration
- Life time achievement Awards
- SS Hayreh Oration
- B. Patanaik Oration
- Enligtening E-posters and Videos
- Sunrise at East-Coast & Jagannath Darshan
- Konark Dance Festival

VRSI Abstract Submission available at www.vrsi.in

Confirmed International Faculties

1. Srinivas Sadda	-	USA
2. Anand Swaroop	-	USA
3. Usha Chakravarthy	-	UK
4. Ranjana Mathur	-	Singapore
5. Rupesh Agarwal	-	Singapore
6. Abdhish Bhavsar	-	USA
7. Arup Das	-	USA
8. Raj Apte	-	USA
9. Kamal Kishore	-	USA
10. Malhar Soni	-	UK
11. Francesco Bandello	-	Italy
12. Prithvi Murthyunjaya	-	USA

Places of Tourist Interest



Bhubaneswar

Lingaraj Temple

Mukteswar Temple

Rajarani Temple

Dhauli Santistupa

Khandagiri

Nandankanan Biological Park



Puri & Konark

Jagannath Temple

Konark Temple

Sea Beach


Cuttack

Barabati Fort

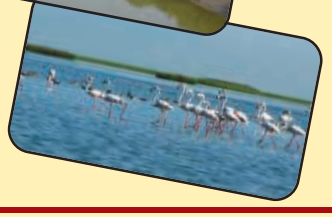
Silver filigree work

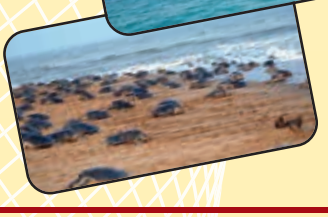

Waterbodies

Bhitarkanika Sanctuary

Gahirmatha

Chilika Lake



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