Original Article

Teleophthalmology as a Model for Detecting Ocular Diseases in Tribal Areas of a North West State in India

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Abstract

Background: Lahaul and Spiti district of Himachal Pradesh, a high altitude tribal district, situated at altitudes varying from 10,000 to 15, 000 ft. above mean sea level is cut off from the rest of the country for nearly 6 months due to heavy snowfall in the mountain passes. In the absence of any ophthalmologist and ophthalmic technician, the provision of eye care is virtually absent. The current study (part of a research project funded by the Indian Council of Medical Research) was conducted with the aim to explore teleophthalmology as a model for detecting posterior segment eye diseases in tribal and inaccessible areas. **Materials and Methods:** Fundus images (taken through fundus photography) of 1000 individuals above 5 years of age with no improvement in vision to 6/6 on refraction and individuals with known history of diabetes mellitus, systemic hypertension, or long standing headache with features of raised intracranial tension irrespective of whether their vision improved to 6/6 or not were sent to tertiary care center (base hospital) from regional hospital (field hospital). Transmitted images (through internet after attaching the details and patient particulars on the excel sheet) were analyzed by the ophthalmologists and the final diagnosis along with the line of management if any was transmitted back. **Results:** Eighty-five percent of the images transmitted were of good quality. Retinal, vitreous, optic nerve head, and choroidal diseases could be detected. **Conclusions:** In the present situation, where trained workforce is unavailable in these areas, teleophthamology is an appropriate tool by which a number of eye diseases can be detected at early stages. Most of them can be treated in these early stages by lifestyle modification and medical management.

Keywords: Retinal diseases, teleophthalmology, telemedicine, tribal areas

Introduction

Telemedicine is a branch of e-health that uses communications networks for delivery of healthcare services and medical education from one geographical location to another. The main purpose of telemedicine is to provide care in places where there is shortage of infrastructural and human resources.[1] Studies have shown that for patients with vascular proliferative disease, for example, retinopathy of prematurity, diabetic retinopathy (DR), age-related macular degeneration (ARMD), and optic nerve pathologies, such as glaucoma, teleophthalmology consultation by a specialist are comparable to traditional face-to-face clinical examination.[2] Satisfaction level and acceptance also is reported to be high in most of the studies.[2] Although there was reduction in the prevalence of blindness due to cataract among >50 years of age in India from 9.4% (1971–1974 survey) to 8.5% (1999–2001 survey), still it is quite high.[3] In India, especially in the rural areas the burden of avoidable blindness is quite high. Blindness and vision impairment remain major public health problems in rural India that need to be addressed.[4] The main reasons for this are the lack of resources be it workforce or infrastructural. Primary eye care refers to, preventive, promotive, and therapeutic and rehabilitation services delivered at community level to avert blindness which is achieved through community participation, inter-sectoral co-ordination, use of appropriate technology, and equitable

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distribution of resources.[5] The Para-Medical Ophthalmic Assistant (PMOA) is the main person rendering primary eye care services in India.[6] The Lahaul and Spiti district of Himachal Pradesh is a high altitude tribal district, situated at altitudes varying from 10,000 to 15, 000 ft above mean sea level. The district is cut off from the rest of the country for nearly 6 months due to heavy snowfall in the mountain passes. There are no specialists of any medical or surgical field in the entire district. In the absence of any ophthalmologist and also ophthalmic technician/PMOA, the provision of primary eye care is virtually absent. As a result, many simple eye-related problems remain undiagnosed and therefore untreated in the residents of this area. Teleophthalmology can help in early diagnosis of these conditions and prevent irreversible vision loss due to some of these diseases. To diagnose posterior segment eye diseases, affecting retina, and optic nerve head (ONH) fundus photography can be done by trained technicians safely, sent through internet to the ophthalmologist located at a main hospital who can analyze these photographs and advise the patient regarding further management. The current study (part of a research project) was conduct with the aim to explore teleophthalmology as a model of detection of ocular diseases in tribal and inaccessible areas.

Materials and Methods

The sampling frame for this study consisted of entire resident tribal population of Lahaul subdivision of Lahaul and Spiti district (population: 31,538 as per 2011 census). A door-to-door survey across entire Keylong subdivision was conducted by project staff to enroll the study participants fulfilling the inclusion criteria as below:

Inclusion criterion

1. Subjects aged 5 years and above, residing in the above area and whose vision did not improve to 6/6 on refraction
2. Subjects with known history of diabetes mellitus, systemic hypertension, or long standing headache with features of raised intra cranial tension.

Exclusion criterion

1. Subjects who refuse to give their consent
2. Subjects whose fundus pictures are unclear due to media haze.

Thus, a total of 1000 individuals were included project staff belonged to the same area and included one ophthalmic technician who was trained in refraction and fundus photography along with two field workers. They conducted the field visits and recruited patients. The eligible participants (1000) identified by the project staff were brought to regional hospital Keylong (field hospital) where visual assessment was done by the ophthalmic technician. The study participants underwent detailed anterior segment evaluation, along with fundus photography using fundus camera, which was installed under the project after dilating the pupils with tropicamide 0.5% eye drops. These fundus photographs were transmitted to the tertiary care center (base hospital) using internet after attaching the details and patient particulars on the excel sheet as per the project protocol. There were variable number of patients that the technician examined each day depending on the climatic conditions, this being a high altitude area with heavy snowfall in winters.

The quality of the fundus photographs was ensured through good patient co-operation, adjustment and focusing of the camera, clarity of the media. The entire procedure was clearly explained to the patients including children. For individuals with disabilities certain adjustments were made, such as alteration in seating arrangement and support to the back of the head. The technician was specifically trained in obtaining fundus photographs.

The pictures were taken in the Digital Imaging and Communications in Medicine (DICOM) mode and converted to other formats (Jpg/JPEG) for sending the data which were viewable on ordinary computers, laptops, I pads, and mobiles.

The pictures thus received were processed and graded at the tertiary care center as "good," "fair," and "poor" quality by two independent ophthalmologists. "Good" was considered when details of vessels, ONH, macula were discernable clearly; "fair," when details were not very clearly seen, but, it was possible to make a diagnosis; "poor" when it was not possible to diagnose the pathology because of the poor image. Based on these parameters, the subject's images were graded and repeat fundus photography was requested in case of poor images. Diagnosis was formulated by three investigating ophthalmologists (GS, RT, and RKS) who were faculty members of the department of ophthalmology only for good and fair quality images/pictures. They used to examine from 1 to 5 patient photographs per day on the working days spending almost 5–10 min on one case. GS also conducted field visits to Keylong where patients were examined directly as well, using 90 D Lens and Slit lamp bio-microscope.

The patients diagnosed with the various diseases were advised medical treatment (e.g., antiglaucoma drugs), lifestyle modification (in diabetics and hypertensives), cataract surgery for those having cataracts (diagnosed on basis of media haze and then directly during site visits) or referred to retina specialists where needed.

Results

One thousand individuals with males representing 51% (508) and females 49% (492) were included in the study. Age range was from 5 to 90 years. 23.4% (66/282) males and 28.1% (110/392) females more than 35 years of age were hypertensive. 3.9% (39/1000) of subjects were diabetic. History of tuberculosis and Anti-tubercular Treatment (ATT) intake was elicited in 4/1000 subjects which amounted to 0.4% of the total subjects. Presenting complaints of the patients are shown in Table 1.

Diagnosis made on the basis of fundus photography

Posterior segment diseases/lesions were detected by the

images photographs sent by the installed camera which were of good and fair quality as explained above. Diseases of posterior segment were diagnosed in 428 (50.53%) of the patients [Table 2]. Among the retinal diseases most common retinal disease identified was hypertensive retinopathy of various grades, followed by ARMD. Overall, retinal disease was identified in 238 subjects [Table 3].

The study presents a model of teleophthalmology in remote tribal area of Himachal Pradesh. The main questions that need to be answered were feasibility, effectiveness; acceptability, and cost of the model.

Feasibility: The main concerns of providing teleophthalogy services in the remote tribal areas are: Limited internet availability, frequent power disruptions, language barrier, limitation of peoples understanding of computers and internet, difficulty in diagnoses of ocular conditions which frequently require specialized equipment to detect several conditions. This model overcomes all the problems effectively. Since most of the ocular problems are not acute and do not require immediate action, therefore real-time teleophthalmology is not required. We therefore took fundus photographs and recorded case histories of the patients and the data was transmitted later on depending on the availability of the internet and power supply. The trained technician belonged to the area and therefore could interact with the patients easily providing a vital link between the local residents and doctors at Tanda. The patients were given a date to come for the opinion regarding diagnosis and advise given by the experts at Tanda.

Cost and effectiveness: 85% of the pictures were of good quality where the diagnosis could be made. The main expenditure incurred in the model are the equipment related, i.e., fundus camera, laptop computers, and salary of the staff. The effectiveness of the model is evident from the fact that 1000 patients were examined. The visits to the area and direct examination of some of the patients was also done to check for the diagnosis and whether the people understood their conditions and whether they were adherent to the treatment/ advise given to them.

Acceptability: The fact that almost 1000 patients presented themselves for consultation shows the acceptability of the model by the people. This was especially because of the fact that the technician who was a local was able to effectively communicate with the people, explains them the problems and the treatments.

Table 1: The symptoms reported by subjects in the study (*n*=1000)

Complaints in general	*n* (%)
Diminution of vision	792 (79.2)
Headache	538 (53.8)
Itching	452 (45.2)
Redness	412 (41.2)
Eye strain	380 (38)
Others*	302 (30.2)

Most of the subjects had more than one symptom (*others include: Floaters, flashes, and night blindness)

Table 2: Diseases of the posterior segment (*n*=428)

Involvement of posterior segment of eye	*n*	Percentage out of patients affected by posterior segment diseases (*n*=428)
Retina	238	55.61
ONH	125	29.21
Vitreous	12	2.80
Choroid	8	1.87
Miscellaneous	45	10.51
Total	428	100

Table 3: The type of retinal diseases detected in the study population (*n*=238)

Retinal disease/lesion	*n*=238, *n* (%)
Hypertensive retinopathy	97 (40.76)
ARMD	61 (25.63)
Medullated nerve fibers	18 (7.56)
NPDR	11 (4.62)
Heredomacular dystrophy	9 (3.78)
BRVO	8 (3.36)
ERM	8 (3.36)
Macular scar	8 (3.36)
CRVO	3 (1.26)
Others*	15 (6.30)

*Others include: Macular hole, BRAO, ocular albinism, CNVM, Macular hemorrhage, PED, retinal break, eales disease, astrocytic hamartoma.

Discussion

This study shows that teleophthalmology based services are feasible in the remote, high altitude area of Keylong (Lahaul and Spiti). Fundus images can be easily captured by a trained technician using a fundus camera after pupillary dilatation. The technician can acquire good quality, 7 field fundus photographs and also special fundus photographs including disc photograph and red-free fundus photographs. These images can then be transmitted through email attachment to the tertiary care base hospital along with the relevant patient data without losing quality of images during the process of transmission. Prathiba and Rema found that teleophthalmology can be a very effective model for improving eye care delivery system in rural and underserved areas of India.[7]

The present study showed that in the absence of an ophthalmologist such posterior segment diseases can be diagnosed early. Retinal vascular diseases could be most easily identified. They included hypertensive retinopathy, DR, Branch Retinal Vein Occlusion and Central Retinal Vein Occlusion. Singh *et al*. in a study of three tribal areas of Andhra Pradesh found that 82.4% of the presenting cases of blindness were treatable, 6.1% preventable and 11.6% of blindness was

caused by posterior segment disorders (including glaucoma). They concluded that this fraction is fairly substantial, highlighting the importance of a dilated fundus examination to assess the cause of blindness in populations.[8] The Aravind Comprehensive Eye Survey Research Group Study showed that the prevalence of DR in rural South Indian population was 10.5%. This was done through teleophthalmology using a mobile eye-screening van.[9]

ONH diseases were more difficult to pick up, due to artifacts, however red free photographs were better for the evaluation of the disc and may reveal more information regarding cup disc ratio, neuroretinal rim and pallor. Kassam *et al*. found that tele glaucoma was useful means of evaluation of the patient's optic disc residing in the remote areas of the world.[10]

We found that macular diseases are most difficult to identify based solely on fundus photographs especially if there is macular edema or thickening due to lack of binocularity which was also noted by De Bats *et al.* and Rudnisky *et al*.[11,12]

This result of the present study shows that teleophthamology services are possible in the tribal areas and can be replicated not only in Keylong, but also in other such inaccessible and remote areas of our country. The patients diagnosed with the various diseases were advised medical treatment (e.g., antiglaucoma drugs), lifestyle modification (in diabetics and hypertensives), cataract surgery for those having cataracts (diagnosed on the basis of media haze and then directly during site visits) or referred to retina specialists where needed. The posterior segment diseases other than glaucoma identified by this technique such as hypertensive retinopathy, nonproliferative DR, and ARMD (which accounted for 71%, i.e., 169/238 of the posterior segment diseases identified) when detected at early stages can be treated by lifestyle modifications only, which can be done by the primary care workers, preventing complications resulting from these later on. We suggest that for patients living in the remote and tribal areas of India, teleophthalmology, using fundus camera and other tools such as optical coherence tomography (OCT) and automated perimeter all of which can be safely be operated by trained staff, should be used as it can help fill the gap in specialized care and provide the services to this population thus preventing avoidable blindness among the populations. This in turn will be a big boost for the primary ophthalmic care services in our country, as primary eye care workers, being native residents of these areas, in telecommunication with the specialists, will be able to guide and provide basic treatment to patients in the early stages of the various eye diseases.

The main strength of the present study was the fact that by conducting field visits the diagnosis of various posterior segment diseases made by the evaluation of fundus photographs was compared and confirmed. The limitation of the study was the fact that other tools like automated perimetry and OCT were not used in this study, which if used could help in further refinement of diagnosis of certain diseases.

Conclusions

Teleophthalmology is a feasible and an effective tool to provide primary eye care services in remote, tribal and inaccessible areas, where specialist care is absent. In the present situation, where trained workforce is unavailable in these areas, teleophthamology is an appropriate tool by which a number of eye diseases can be detected at early stages. The added advantage of this is that public awareness regarding eye diseases also increases resulting in improved health-seeking behavior of the community.

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Conflicts of interest

There are no conflicts of interest.

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