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Editorial

Applications of artificial intelligence in ocular oncology

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Ocular neoplasms can be divided into two types- benign and malignant. Malignant ocular tumors comprises primary malignant tumors (arising from the eyeball and its adnexa), secondaries (malignant lesions extending from surrounding structures like nose, paranasal sinuses and cranial fossa) and metastatic tumors (malignant deposition from distant organs). Primary ocular malignancies originate either from inside the eyeball (intraocular malignancy) or from ocular adnexa (orbit, eyelid and conjunctiva). Commonest intraocular malignancies are retinoblastoma (in pediatric age group) and malignant melanoma (in adults). Both of them are very aggressive and life threatening malignancy if left untreated. Primary orbital malignancies include rhabdomyosarcoma, lacrimal gland carcinoma and orbital lymphoma. The most frequent eyelid malignancies are basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and sebaceous gland carcinoma (SGC).[1] Sebaceous gland carcinoma of eyelid is most aggressive, locally invasive tumor which can metastasize to liver, brain and lymph nodes, often associated with high mortality. Ocular malignancy may lead to cosmetic disfigurement, loss of vision and life. Sebaceous gland carcinoma of eyelid is a great masquerader as it may mimic benign lesions like chalazion and chronic blepharitis etc.[2]

Sometimes benign and malignant neoplasms have overlapping features, as a result of which it could be misdiagnosed or there could be delay in diagnosis and tumor metastasis. In developing countries these lethal ocular malignancies are often diagnosed late in the advanced stages where extra ocular dissemination has already occurred which results in poor prognosis and lesser chances of disease free survival. However early diagnosis and appropriate intervention can result in the best aesthetic and functional outcomes.[3] The factors responsible for delayed diagnosis of ocular tumors in under developed or developing countries are poor socioeconomic status, illiteracy and lack of awareness. Shortage of experienced ophthalmologists / ocular oncologists in remote places. In primary care centers, differentiating a malignant eyelid tumor from a benign tumor can be challenging for the examining physician due to the relatively small size, variability in clinical presentation, and minimal ophthalmologic training in the medical school.[4,5] Oculoplastic surgeons also have only 70% accuracy in diagnosing eyelid tumors.[4]

Thus, there is a great need of system which helps the experts in early detection of ocular tumors especially malignant ones with the help of data sets eg. clinical images of eyelid tumors, fundus image of retinoblastoma and radio-images). Recently artificial intelligence (AI) plays important role in early detection of various ocular malignancies. Due to the reliable performance, AI system could be utilized both at the screening stage and at the disease confirmation stage, promoting the early detection of malignant eyelid tumors, reducing the medical costs and

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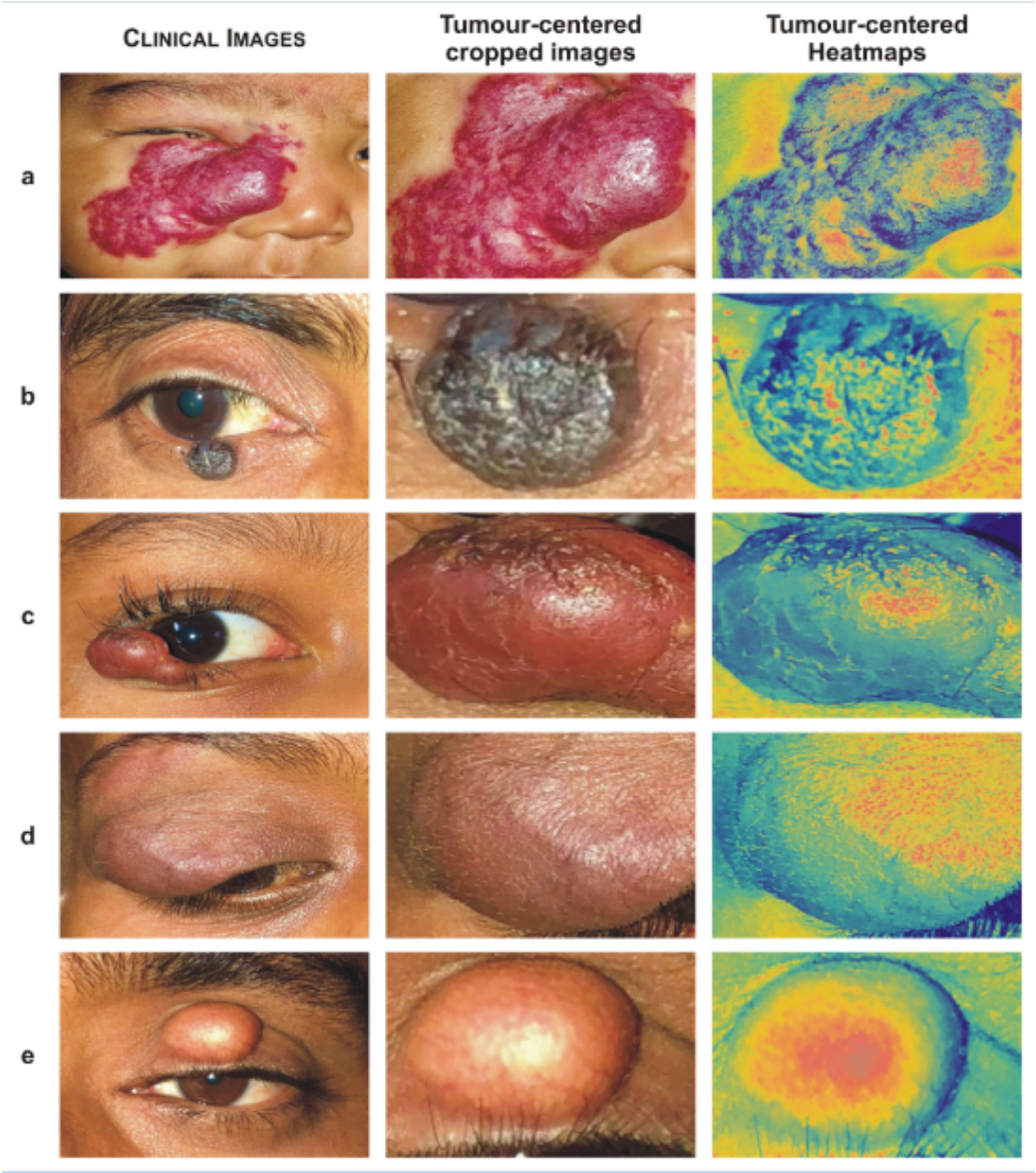

Fig. 1: Photographic images, cropped images and corresponding heat maps of benign eyelid tumors (**a:** Capillary Hemangioma, **b:** Compound Nevus, **c:** Pyogenic Granuloma, **d:** Neurofibromatosis, **e:** Dermoid Cyst.)

workload by avoiding the need for the further examination of evidently benign eyelid tumors.[6]

Earlier studies have been reported on application of AI in analysis of breast histopathology,[7] detection of skin cancer[8] & lung cancer[9] which inspire the study / implication of AI in detection of eyelid tumor,[10] detection of retinoblastoma[11] and study of signaling processes of uveal melanoma.[12]

Artificial intelligence was proposed by Dartmouth scholar John McCarthy in 1956 which refer to hardware or software that exhibits intelligent behavior.[13] Simply we can say AI is an ability of computer that can imitate program to function like human brain.[14] Two subsets of AI are Machin learning (ML) and Deep learning (DL). Machin learning occurred in 1980's and it is a group of mathematical algorithms that learn from experience (data) like human learning behavior to perform new tests.[15] ML automatically detect patterns from data set and then incorporate this information to predict future data under uncertain condition.[16] The two forms of ML are supervised ML and unsupervised ML.[17] Supervised ML has high level of performance.[17] It requires three labelled data set used for traning, validation and testing.

Deep learning (DL) occurred in 2000'sis a burgeoning technology of ML and has revolutionized the modern society by helping in object's recognition in images, real time language translation, device manipulation via speech

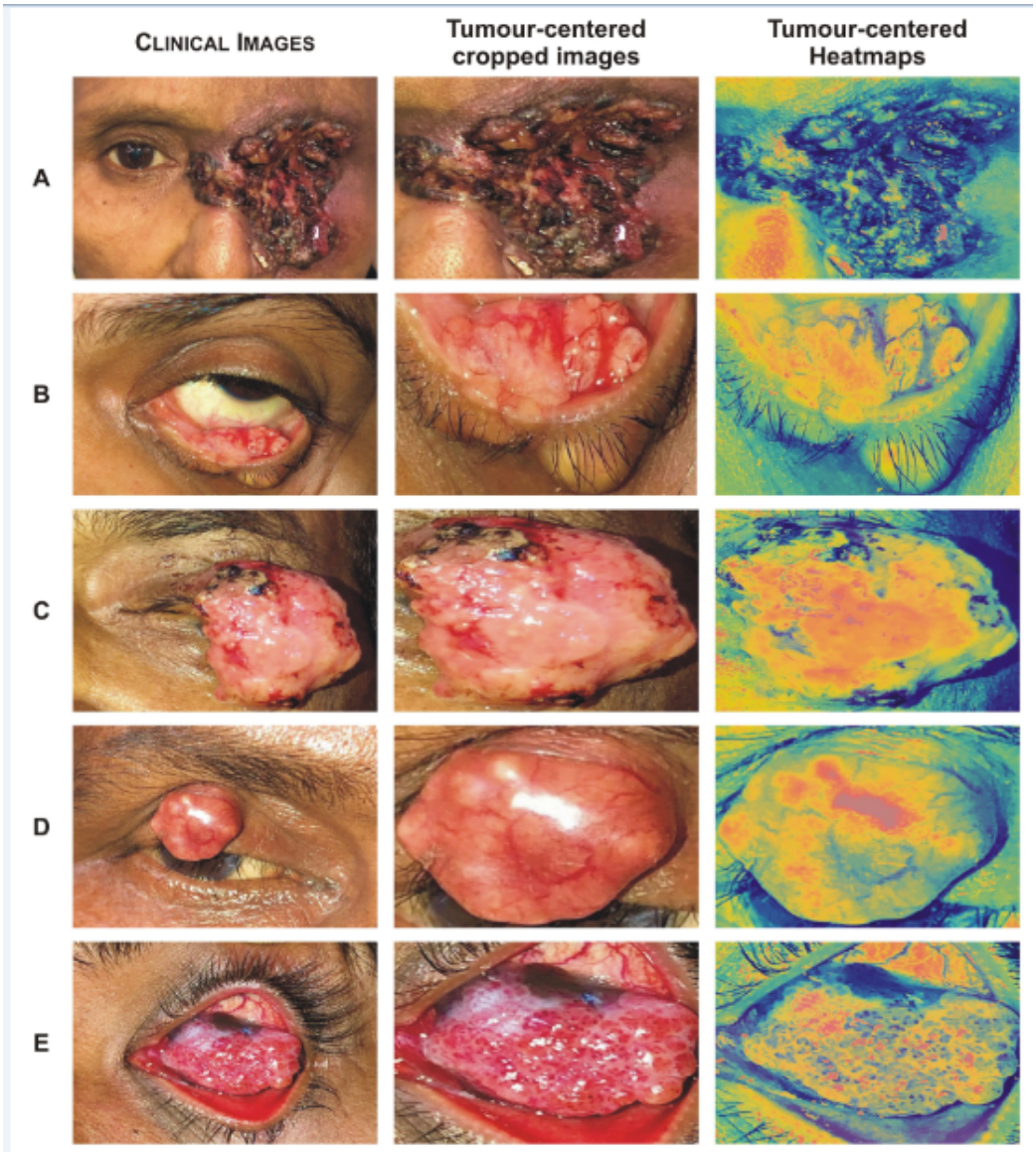

Fig. 2: Photographic images, cropped images and corresponding heat maps of malignant eyelid tumors (**a:** Basal Cell Carcinoma, **b:** Sebaceous Gland Carcinoma, **c:** Squamous Cell Carcinoma, **d:** Sebaceous Gland Carcinoma.) & **e:** Ocular surface squamous cell carcinoma (OSSN).

etc. DL is way of classifying, clustering and predicting things by using a neural network (set of algorithms) like human brain that has been trained on vast amounts of data. Several methods of DL include long term and short term memory, deep recurrent neural network (RNN) and convolutional neural network (CNN). The most commonly used DL method in clinical diagnosis by image recognition is CNN. DL algorithms are known as 'black boxes'. The networks generate features (comprehensive and discriminative) of high dimension to be accessible for human interpretation. Way to analyze pattern and make a decision at the image level is little known.[18] Heat maps can show image level predictions which showed highly possible abnormal region in the input image for analysis and diagnosis.

Building AI model for detection of ocular tumor need raw data in the form of multimodal images such as clinical images of tumor, fundus image, histopathological microphotographs, radio-images (X-ray, CT Scan, MRI,PET-CT and angiography etc.). The steps for developing AI model are pre-processing of image data, training, validating and testing the model and finally evolution of performance of trained model. Data pre-processing is necessary to increase prediction efficiency of AI model. Noise reduction of data can enhance the quality of data and optimize the learning process. Then data should

be integrated and adjusted to common scale. Most efficient AI model should be well validated and tested.

Li Z et al developed eyelid tumor detection system (ETDS) using the faster region based convolutional neural network (Fasrter R-CNN).[19] The proposed algorithms automatically locate and crop eyelid tumors from images which remove the background noise around tumor image. Each cropped image contains one type of tumor. The cropped image of ETDS were randomly split for validation and testing of a deep learning classification system. They employed the Grade-CAM technique to create visual explanation for the decision. Heat maps is a technique that can highlights highly possible abnormal regions in the images (Figures 1 and 2).

Jaya I et al demonstrated AI model to identify retinoblastoma by using the extreme learning machine by using retinal fundus images of fundus camera used as input to identify retinoblastoma. They did pre-process of image by grey scaling, open channel, contrast stretching, thresholding and feature extracting by Zoning method. There proposed model had ability to detect retinoblastoma with an accuracy of 92%.[11]

1. Conflict of Interest

None.

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