Artificial intelligence in laser refractive surgery – Potential and promise!

Laser refractive surgery is about precision. Whether it is screening or surgery, there is no scope for errors, owing to the age and profile of patients undergoing these procedures.[1,2] A majority of them are for cosmesis, intolerance to contact lenses, or professional reasons, including sportsmen. Case selection and type of technique is, therefore, paramount to ensure optimal results. At the time of investigations and scans, there can be subjective variations in the interpretation of topographic maps and subtle differences between the devices used.[3] Some organizations screen potential employees or recruits for previous refractive surgery.[4] Evidence of these procedures in corneas donated to eye banks for transplantation of donor tissue may also be a requirement.[5] Hence, an objective assessment across demographic variations and instrumentation would add to the success of planning and outcome evaluation.

Artificial intelligence (AI), based on machine learning and deep learning, is gaining popularity and acceptance in medicine and healthcare with its ability to perform much better than human beings, especially in image recognition and analysis.[6] While AI in ophthalmology has been used for diabetic retinopathy, age-related macular degeneration, glaucoma and cataract, and its application in corneal conditions is being explored.[7-12] Different machine learning algorithms have been used to identify eyes with preclinical or subclinical keratoconus.[13-15] Based on the experience from these algorithms, it is possible to screen for cornea ectasias with good accuracy before refractive surgery and to identify those in whom the surgery would be a contraindication.[16] All preoperative data from 10,561 eyes were combined to form a model to predict suitability for refractive surgery with an accuracy of 93.4%, including laser-assisted epithelial keratomileusis (LASIK) and small incision lenticular extraction (SMILE).[17]

Another possible avenue for AI includes predicting laser refractive surgery outcomes and enhancing the accuracy for SMILE outcomes, with the current algorithms' performance being comparable to that of an experienced surgeon for safety, efficacy, and predictability.[18,19] It is now also possible to identify patients with a risk for post-surgical ectasia, especially post LASIK.[20] Based on the preoperative Pentacam data of 2980 stable LASIK eyes, a machine learning algorithm was able to detect 71 eyes with ectasia susceptibility and 182 eyes with clinical keratoconus.[21] Another model with the Orbscan could detect post LASIK ectasia with 93% sensitivity and 92% specificity.[22] With better technology and surgical options available, the number of patients opting for refractive error correction is increasing. They will eventually need to undergo cataract surgery and calculation of the corneal power is paramount for intraocular lens (IOL) selection. AI can be used to prevent erroneous calculations and predict accurate IOL powers to reduce the likelihood of residual refractive errors.[12]

In India and neighboring Asian countries, there is a growing prevalence of myopia with more patients seeking refractive error correction.[23] Automated and objective categorization of scan images to provide salient corneal information will go a long way to support clinical decision making and lead to better individual risk assessment and outcomes. With the ongoing pandemic, there is a potential for telemedicine and AI applications in inaccessible regions. Similar to those in other fields, challenges of AI in ophthalmology are validation and applicability of AI models, implementation barriers, standardization of data sets, and ethical issues. Some models are less predictable for eyes with high myopia (>−7D) and astigmatism (>2D).[24] Nonetheless, ophthalmology has the advantage of image-based diagnosis and AI can facilitate quantification of disease severity, surgical planning, and longitudinal monitoring of treatment response. AI, as an industry, is growing in leaps and bounds and will ultimately be a partner for an improved and accurate refractive surgical practice.[25]

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