Application of Artificial Intelligence (AI) to Predict Success of Selective Laser Trabeculoplasty (SLT) To Reduce Intraocular Pressure (IOP)

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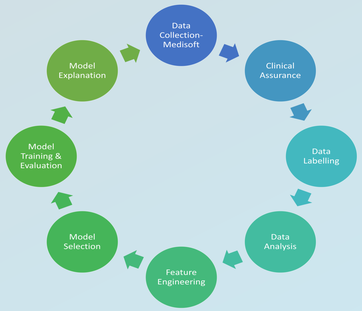
Royal College of Ophthalmologists Annual Congress May 2023 - Birmingham

Introduction

- Selective Laser Trabeculoplasty (SLT) is well accepted treatment to reduce intraocular pressure (IOP) in ocular hypertension (OHT) and chronic open angle glaucoma (OAG).
- Currently, there is no literature/information available to predict SLT success/ failure automatically in individual patient prior to the laser.
- We used artificial intelligence to predict success / failure of SLT and elapsed time of success.
- This model will augment the decision making of clinicians to offer personalised first line of treatment i.e., drops versus laser.

Method

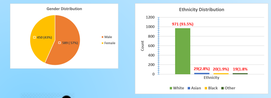
- Data collected from Electronic database - Medisoft for >9 years,
- Data validated manually from free text boxes holding clinical visit notes to collect maximum attributes.
- Inclusion Criteria:
  - Both eyes if had SLT with minimum of 6 months follow up dataset.
  - All SLTs (First SLT or repeat SLT with or without drops) done at CHFT between June 2012 to December 2021.
- Comparison of baseline IOP to post SLT IOP to establish the elapsed month of success i.e., at 1 month,2 months, 3 months and 4-6 months.
- Unsuccessful cases are marked as 0 - used for building the model.
- Patients with IOP reduction of >= 20% within 6 months are labelled as success of SLT.



Dataset Key Features

- Single Centre data – Calderdale and Huddersfield NHS Trust (CHFT)
- 74% SLTs done by one surgeon * 360 degree SLT done in 98%
- First SLT 85%, Phakic 83%, previous glaucoma surgery/YAG PI in 10%

	Patients	SLTs
Total Numbers	568	1121
Eligible after the data validation	533	1039



Age 37-94 years
46% between 65-80

Original features 54

Model accepted features 22

Classification model used to predict SLT success

Training Data 831 eyes (80%)

Testing Data 208 eyes (20%)

Aim

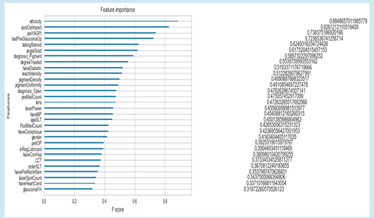
- To predict success of SLT for a patient using only pre SLT clinical dataset.
- To predict the duration of onset of reduction in IOP(>= 20%)

Model Implementation

- 1039 eyes from 533 patients with 31 features were selected following clinical assurance
- Each observation was labelled with the elapsed month of success, up to 4 and '0' for unsuccessful cases
- Data transformations and feature engineering were applied to make the data set fit for modeling
- Model identified 22 features out of 31 as relevant
- 3 different classification models including Deep Neural Network were evaluated for selecting the best model
- The transformed data was split 80:20 ratio for training/validation and independent testing
- Various optimisation techniques were followed to tune model achieve optimal accuracy
- The model performance was evaluated with independent test data set establish the accuracy
- The explanation from the model was generated to identify the reasoning of the prediction

Attributes / Predictors of Success

- Patients' demographics –ethnicity, age, gender,
- Past medical History – especially steroids, asthma, HT, DM
- Ophthalmic History – YAG iridotomy, IOL, VR surgery in <6 months, Intravitreal injections,.
- IOP – Pre SLT clinic visit and at subsequent visits.
- Clinical -CCT, angle grading, density of pigmentation, pattern of pigmentation -scattered or uniform,
- SLT details –total number of laser spots,, laser power, grading of reaction (mild, moderate to good),
- Eyedrops pre SLT and post SLT including lubricants



3 models were used to identify most relevant data attributes(features) out of 31 influencing the SLT success duration and another 3 models were used to select the best feature set. The one above was the best combination of attributes identified by XGBoost Classifier delivering highest prediction accuracy.

Limitations of Dataset

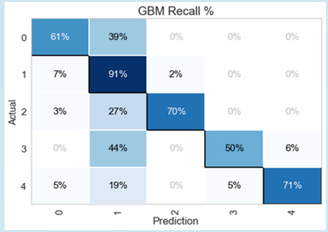
- Variable data entry threshold on electronic record keeping affecting even at single centre study
- As per AI model requirement 1000 SLTs were very less compared to the complexity of 54 features. not providing enough variations for model to predict with higher accuracy
- Data collection and compilation was labor extensive as critical attributes were in free text
- Time constraints and lack of powerful experimentation platform to run resource hungry models.

Results

Classification model of AI in our research

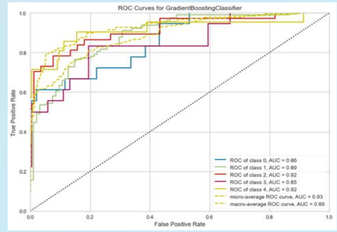
- Could predict the possibility of success of SLT with 91% accuracy at 1 month .The prediction accuracy gone down to 70% at month 2 and month 4.
- Overall accuracy of prediction was 81%. (Variability of success prediction accuracy was due to variability of available data at given FU intervals. As maximum available FU was at 1 month, model could train well and predict with highest accuracy to 91%.
- Sensitivity for unsuccessful cases was just over 61% as our SLT cohort had very few unsuccessful cases (<10%) at end of < 6months

Key Results From Testing Dataset



.Sensitivity of our AI Model

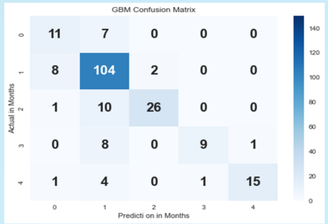
- Sensitivity is highlighted at diagonal values
- Vertical column values - shows prediction by model
- Horizontal column values - actual value in test data.

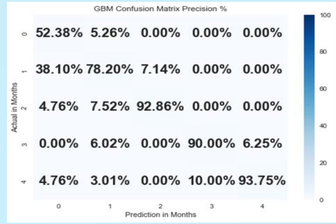


Sensitivity Vs. Specificity of our AI Model

- The Area Under Curve(AUC) for each success class is >=0.8 implying model was > 80% correct in prediction.
- The SLT success for 2 and 4 months have higher AUC signifying model was better trained with '2' and '4' months cases.

Prediction at given months





- first column is for prediction of unsuccessful cases
- first row is actual value of unsuccessful cases.
- The diagonal values represent the model predicted correctly for each success cases.

- The precision for unsuccessful cases was low(52%) - as our cohort had very low numbers for failed SLTs
- The prediction for successful cases at month 2 to 4 - >90%
- Overall accuracy of the model is 80%.

Limitations of Recommendations

- No literature/background information available in public domain for automated prediction of SLT success to validate our model.
- Our cohort got 97% white population- For wider application of the results need to be aware of this ethnic limitation .
- Higher accuracy of predication at 1 month –consistent with availability of maximum post op data at one month than others
- Selection of all attributes are as per single clinician's experience and personal outcome results, multicenter data will decrease this possible bias

Why To Use AI for Predicting SLT Success?

- Jan 2022 updated NICE (National Institute for Health and Care Excellence) guidance advises to offer 360 degrees SLT as the first line of treatment in OHT and COAG.
- SLT is known to be a success in 70-80% patients,
- Across the UK, Ophthalmology departments are already struggling to cope up with capacity crisis even 2 years post covid.
- The NICE guidance led to rise in those numbers further as all eligible patients are expected to offer additional SLT laser appointments along with post op follow ups
- If AI can predict the success /failure in an individual patient, then almost 20-30% of patients may not need to undergo SLT as eyedrops would be the effective treatment option for them.

Novelty of the Research

This is the first research on application of artificial intelligence to predict success of SLT.
No robust evidence/literature of automatic predictions of SLT success/ Failure is available

Clinical Implication

- AI can predict the possibility of success of SLT by making use of pre SLT data at diagnosis itself.
- This will help clinician to avoid offering SLT to all eligible patients especially to those 20-30% of patients where SLT is less likely to be effective .
- AI model will help up to make optimum use of clinical, administrative resources while offering personalized treatment to the patient which is crucial in current capacity crisis and challenges due to financial constraints.
- AI model can also help us to minimize random FU visits by guiding us onset of IOP reduction.

Conclusion

- The model, in spite of various data issues, has delivered 80% accuracy and 70-90% sensitivity and precision across all 4 success durations considered to be very good in healthcare
- The model performance can significantly be boosted with the use of multi-center SLT cases providing variation and volume required for this noble use case
- The research outcome proved to be effective & research objectives were met despite various challenges

Contribution

- This AI model was developed and accepted towards main research project for post graduate diploma of Masters in Artificial Intelligence by Mr Bilash Dash from Huddersfield University in collaboration with Calderdale and Huddersfield NHS Foundation Trust. No conflicts of interest.
- Dr Shevade was Clinical Mentor throughout the project also contributed towards data collection, validation and results evaluation

Declaration /Acknowledgments

- No conflicts of interest
- No funding.

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