Multi-institutional collaborative research using ophthalmic medical image data standardized by Radiology Common Data Model (R-CDM)

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Background

- Unstructured data which is beyond the scope of OMOP-CDM standardization is difficult to be used for multi-institutional collaborative research.
- Radiology Common Data Model (R-CDM) has been developed to standardize the terminology and structure of medical imaging data, which is representative unstructured data.
- In this study, a multi-institutional collaborative research was conducted by establishing an R-CDM database that standardized ophthalmic medical imaging data at two tertiary hospitals in Korea.

Methods

1. Standardizing optical coherence tomography (OCT) data into R-CDM

- Ajou University School of Medicine (AUSOM)
  - Taken with ZEISS medical device during 2013.01 – 2022.04
- Seoul National University Bundang Hospital (SNUBH)
  - Taken with HEIDELBERG medical device during 2006.07 – 2019.08
- Standardize OCT data into R-CDM format (Figure 1)

Radiology Occurrence table

study_id	person_id	study_date	modality	manufacturer	protocol_concept_id
1654861	3154381	2012-02-28	OCT	ZEISS	4213040 (Optical coherence tomography)
5156120	3215613	2012-08-15	OCT	ZEISS	4213040
3202305	1564510	2013-04-13	OCT	ZEISS	4213040

Radiology Image table

image_id	series_id	study_id	series_type_source_value	file_path
12345342	3752728	1654861	RNFL analysis report	E:₩E4038199₩I05010.dcm
45395345	7827354	5156120	Macular cube analysis report	F:₩E3995248₩I06882.dcm
78676888	7837321	3202305	GCIPL analysis report	F:₩E3235248₩I06880.dcm

Figure 1. R-CDM Standardized OCT data

2. Design study to analyze changes in retinal thickness due to chronic disease

- Patient cohort with hypertension (HTN), patient cohort with diabetes mellitus (DM), normal comparator cohort were created. Design of the HTN and comparator cohort can be seen in Figure 2.
- Gender and age of the patient cohort and the control cohort were matched by conducting 1:2 propensity score matching (PSM) method.
- OCT data of the left eye, which was taken last during the period in which the patient was in the cohort, was used for analysis.

3. OCT data extraction through interworking of R-CDM and OMOP-CDM

- By linking OMOP-CDM and R-CDM, an environment has been established to extract specific image data taken by a specific patient cohort.
- The previously set hypertensive, diabetic, and control cohorts were constructed through OMOP-CDM, and then the OCT data they took were extracted through R-CDM.

4. OCT data extraction through interworking of R-CDM and OMOP-CDM

- From the OCT data of AUSOM, retinal thickness feature was extracted using the easyOCR package of python. From the OCT data of SNUBH, retinal thickness feature was extracted using the OCR machine learning model developed in-house.
- The RNFL thickness and central macular thickness data of AUSOM and RNFL thickness data of SNUBH Hospital were successfully extracted and used for analysis.

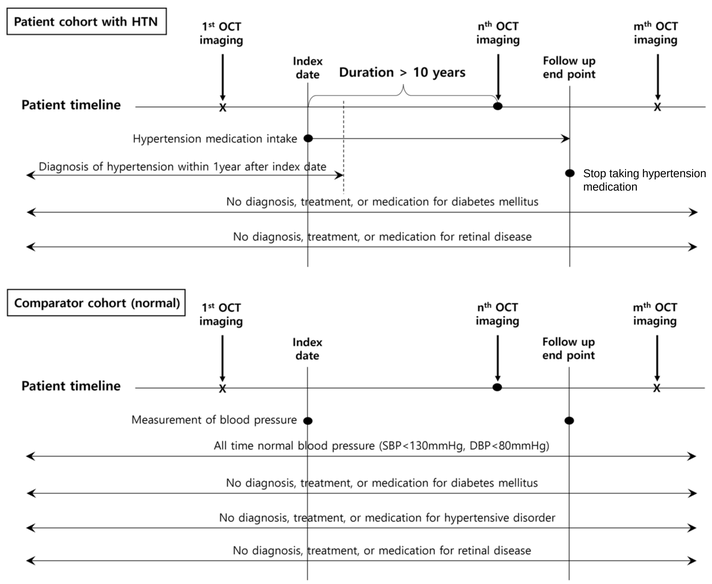

Figure 2. Design of the HTN and comparator cohort

Results

1. Composition of R-CDM standardized OCT data

- 261,874 and 475,626 OCT data from AUSOM and SNUBH were standardized in R-CDM format
- OCT data containing features of retinal thickness are central macula, GCIPL, and retinal nerve fiber layer (RNFL) thickness reports, which are colored in red, yellow, and green, respectively (Figure 3).

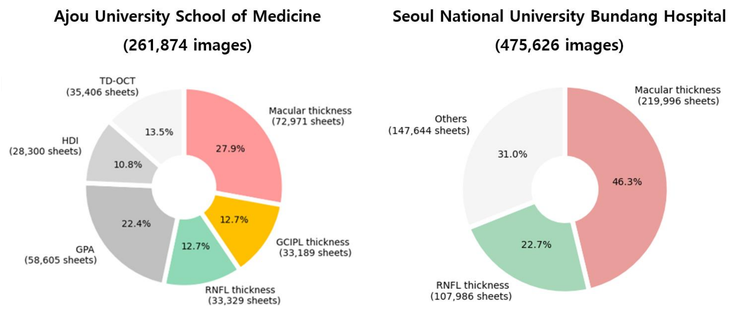

Figure 3. Composition of OCT data in each hospital

2. Analysis of retinal thickness differences between cohorts (Figure 4)

2-1) Patient cohort with HTN VS comparator cohort

- The HTN cohort (101 patients) and control cohort (176 patients) each had an average RNFL thickness of 80.70µm, 86.80µm.
- The HTN cohort (52 patients) and control cohort (85 patients) each had an average central macular thickness of 265.73µm, 273.05µm.
- RNFL thickness, and Central macular thickness from hypertension cohort was significantly lower than that of the normal control cohort.

2-2) Patient cohort with DM VS comparator cohort

- There was no significant difference in RNFL thickness and central macular thickness between the DM cohort and the control cohort.

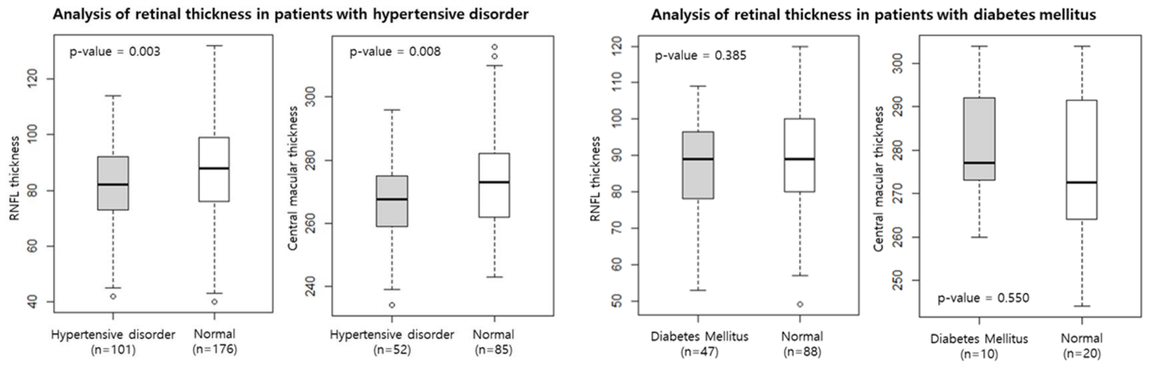

Figure 4. Differences of retinal thickness between cohorts

Conclusions

- In this study, OCT data of AUSOM and SNUBH were obtained for research purposes and standardized in the form of R-CDM.
- The retinal thickness was compared between the patients with chronic disease and the normal comparator cohort, and the retinal thickness was significantly lower in the patients with hypertension for more than 10 years.
- It is meaningful in that multi-institutional collaborative research which combines clinical and image data in various ways can be conducted very efficiently.

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