

# Predicting Ocular Neuropathy in Thyroid Eye Disease

Yi Ai Chen, Niamh Evenhouse, Mrinalini Garg, Kitu Komya, Caitlin Shener, Mohini Vembusubramanian

# Subjects

Data for experimental (TED) and control (no TED) groups

Experimental group: **assumed subjects' right and left eye independent**, used each eye as separate observation

Control group: **assumed subjects' right and left eye same**, used left eye only

|                    | Control group<br>(No TED) | Experimental group<br>(TED present) | <b>Total</b> |
|--------------------|---------------------------|-------------------------------------|--------------|
| Number of patients | 21                        | 24                                  | <b>45</b>    |
| Number of eyes     | 21                        | 48                                  | <b>69</b>    |

# Variables

**Outcomes:** Presence of Ocular Neuropathy (ON), Strabismus, Decompression

No = 0

Yes = 1

**Predictors:**

Numeric: CAS Score, Lagophthalmos, OSDI Score, Hertel, Fat Volume / Orbit Volume, Muscle Volume / Orbit Volume, Medial Rectus Muscle Volume

Categorical: Strabismus, Medial Wall Bowing, Decompression

# Tables of TED by right or left eye, decompression, strabismus, and medial wall bowing\*

|            | ON (No) | ON (Yes) | Total |
|------------|---------|----------|-------|
| Right (OD) | 18      | 6        | 24    |
| Left (OS)  | 21      | 3        | 24    |
| Total      | 39      | 9        | 48    |

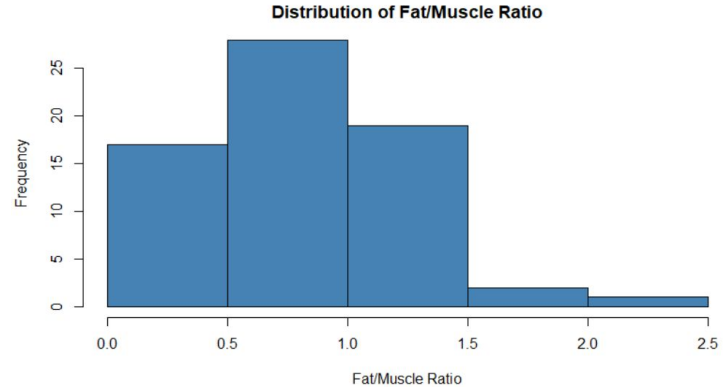
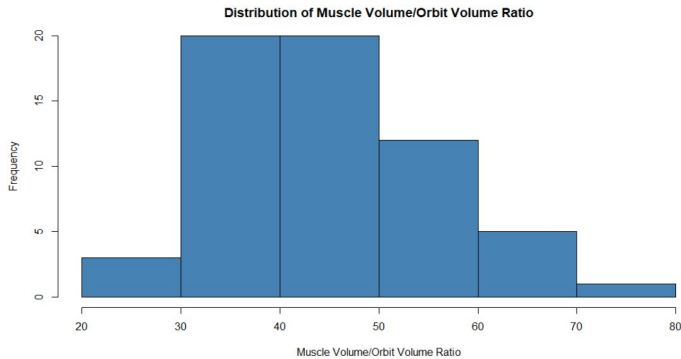
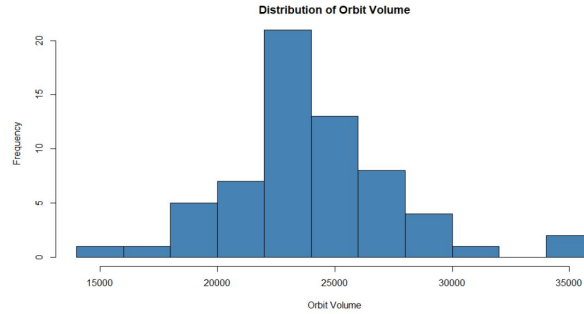
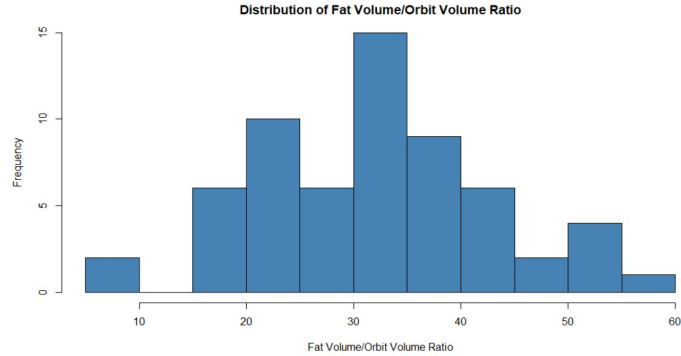
|                     | ON (No) | ON (Yes) | Total |
|---------------------|---------|----------|-------|
| Decompression (No)  | 21      | 1        | 22    |
| Decompression (Yes) | 14      | 4        | 28    |
| Total               | 35      | 5        | 40    |

|                  | ON (No) | ON (Yes) | Total |
|------------------|---------|----------|-------|
| Strabismus (No)  | 16      | 4        | 20    |
| Strabismus (Yes) | 23      | 5        | 28    |
| Total            | 39      | 9        | 48    |

|                  | ON (No) | ON (Yes) | Total |
|------------------|---------|----------|-------|
| Medial Bow (No)  | 28      | 2        | 30    |
| Medial Bow (Yes) | 7       | 3        | 10    |
| Total            | 35      | 5        | 40    |

\*Used Fisher's Exact Test to test independence between ON and decompression, strabismus, and medial wall bowing. Results showed that all p-values are insignificant; we cannot reject the null hypothesis of independence.

# Histograms of some numerical predictors





# Right - Left Eye Independence

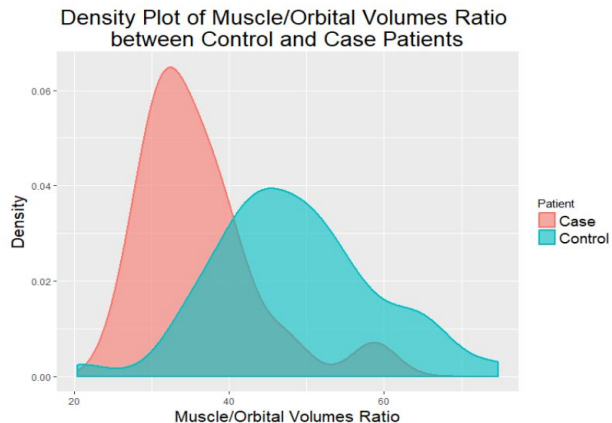
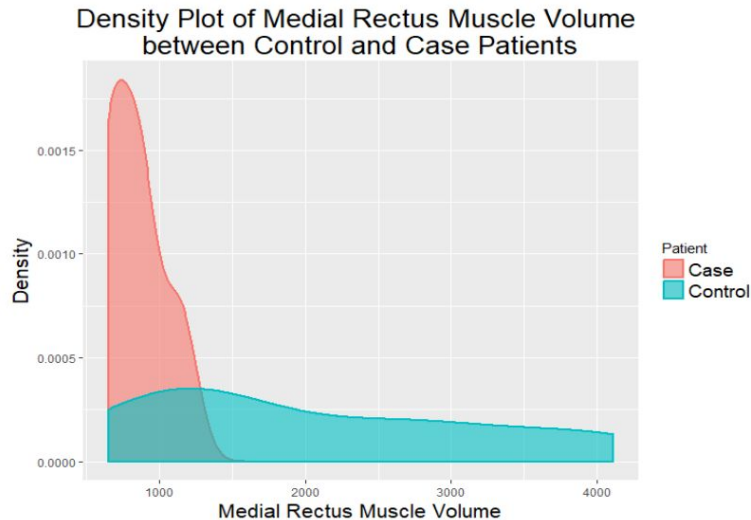
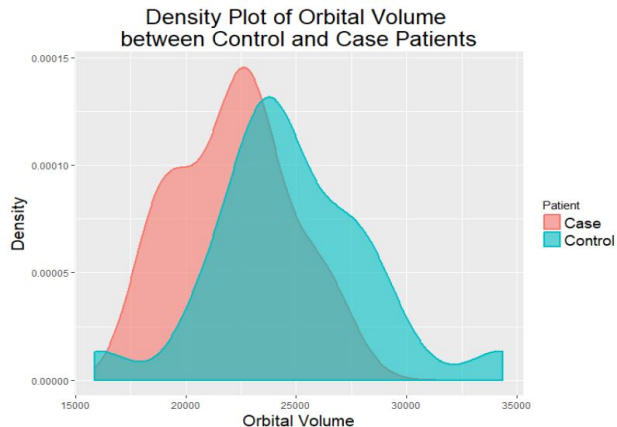
1. Among **experimental** group, right and left eye measurements are **independent**.

| Variable      | OS mean | OD Mean | OS SD   | OD SD  | Independent* |
|---------------|---------|---------|---------|--------|--------------|
| Lagophthalmos | 0.5     | 0.65    | 0.63    | 0.8    | ✓            |
| Hertel        | 21.852  | 24.34   | 4.09    | 4.61   | ✓            |
| FV/OV         | 34.95   | 30.76   | 12.84   | 11.38  | ✓            |
| MV/OV         | 46.87   | 49.85   | 8.52    | 12.22  | ✓            |
| Medial Volume | 1904.09 | 2258.25 | 1080.69 | 1276.7 | **           |
| ON Proportion | 12.5%   | 25%     | 0.34    | 0.44   | **           |
| Medial Bowing | 20%     | 30%     | 0.41    | 0.47   | **           |

\* Independence checked using non-parametric spearman's coefficient of correlation for numerical variables.

\*\* Small number of observations

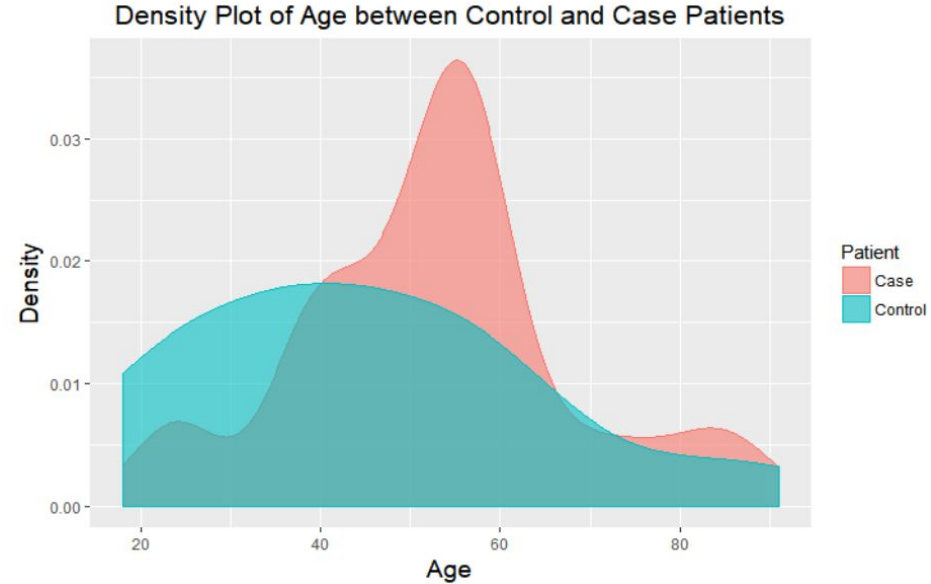
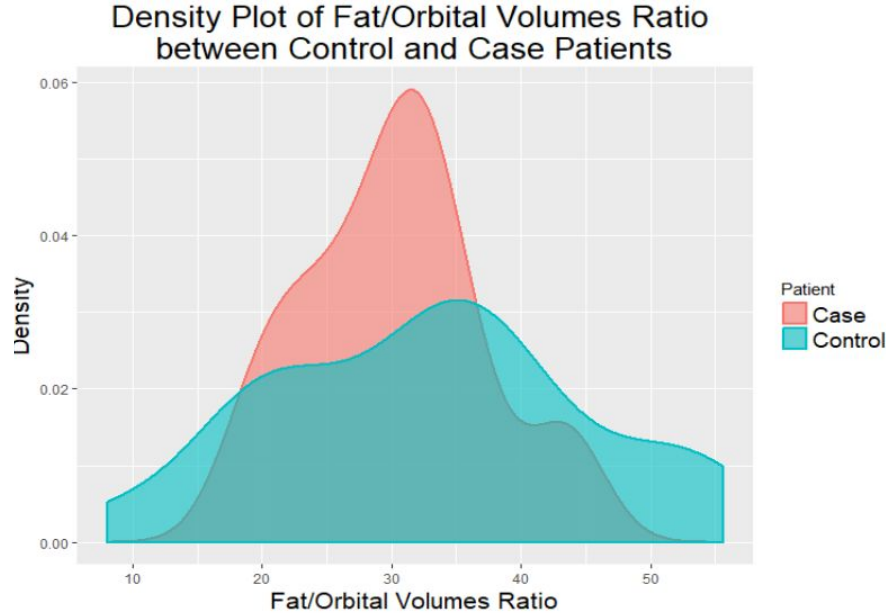
# Control - Experimental Comparison: significant vars



The distributions of orbital volume, muscle/orbital volumes ratio, and medial rectus muscle volume are significantly different between case and control patients



# Control - Experimental Comparison: non-significant vars



The distribution of fat/orbital volumes ratio and age are not significantly different between case and control patients

# Predicting Ocular Neuropathy: no significant predictors

**Method:** Logistic Regression **Output:** Presence of Ocular Neuropathy **Predictors:** In table below

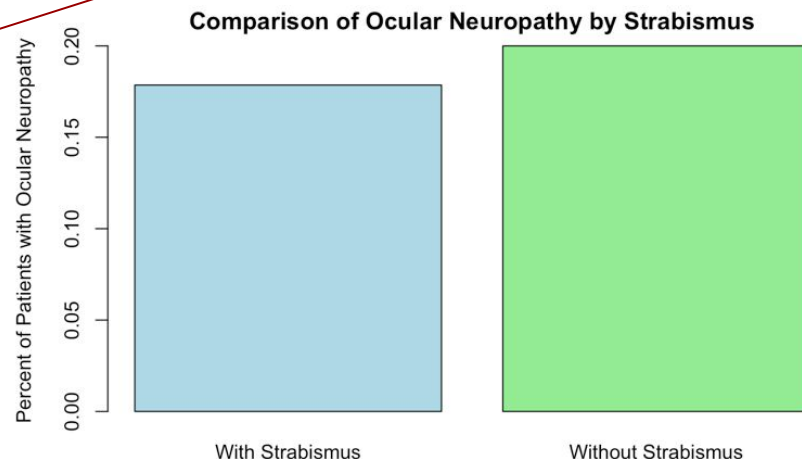
|                          |                   |   |
|--------------------------|-------------------|---|
| CAS Score                | type= numeric     | range= 0 to 6                                 |
| OSDI Score               | type= numeric     | range= 4.167 to 100                           |
| Lagophthalmos            | type= numeric     | range= 0 to 2                                 |
| Strabismus               | type= categorical | 0= Not Present 1= Present                     |
| Hertel                   | type= numeric     | range= 11 to 40                               |
| Fat Vol/ Orbit Vol       | type= numeric     | range= 8.077 to 55.576                        |
| Muscle Vol/ Orbit Vol    | type= numeric     | range= 5041 to 18649                          |
| Medial Wall Bowing       | type= categorical | 0= not present 1= present                     |
| Decompression            | type= categorical | 0 = not present 1= present                    |
| Medial Rectus Muscle Vol | type= numeric     | range= 649.8 to 4111.2<br>(48 missing values) |

# Exploring Differences in Means and Probabilities

| Mean of | CAS.score | OSDI.score | orbit_volume | muscle_vol | fat_vol | medial_rectus_muscle_vol |
|---------|-----------|------------|--------------|------------|---------|--------------------------|
| ON: Yes | 2.66      | 47.5       | 24464.25     | 11223.36   | 8718.93 | 1759.774                 |
| ON: No  | 2.66      | 51.6       | 26108.66     | 12933.60   | 6835.62 | 2616.837                 |

Welch Two Sample t-test

data: medial\_rectus\_muscle\_vol by optic\_neuropathy  
t = -1.3678, df = 8.1308, p-value = 0.208  
alternative hypothesis: true difference in means is not equal to 0  
95 percent confidence interval:  
-2297.9466 583.8212  
sample estimates:  
mean in group 0 mean in group 1  
1759.774 2616.837



# Predicting Strabismus: no significant predictors

**Method:** Logistic Regression **Output:** Strabismus Yes or No **Predictors:** In table below

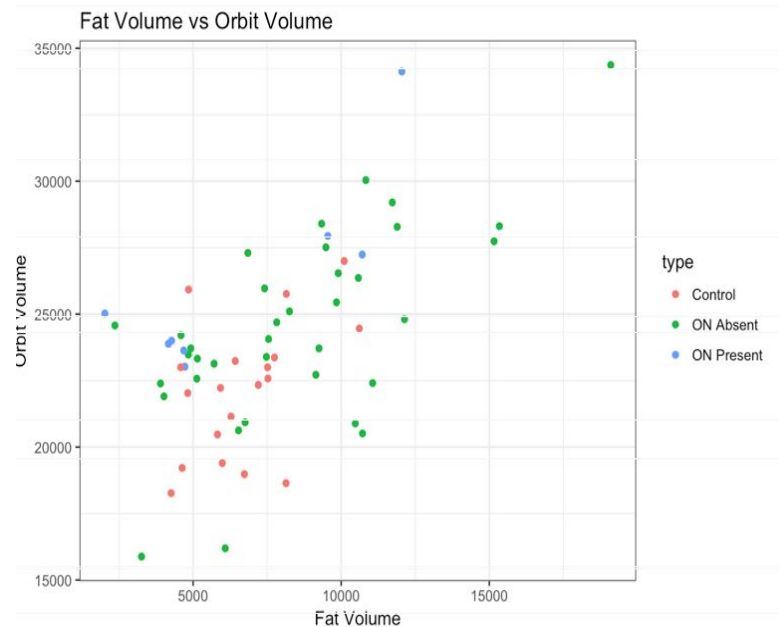
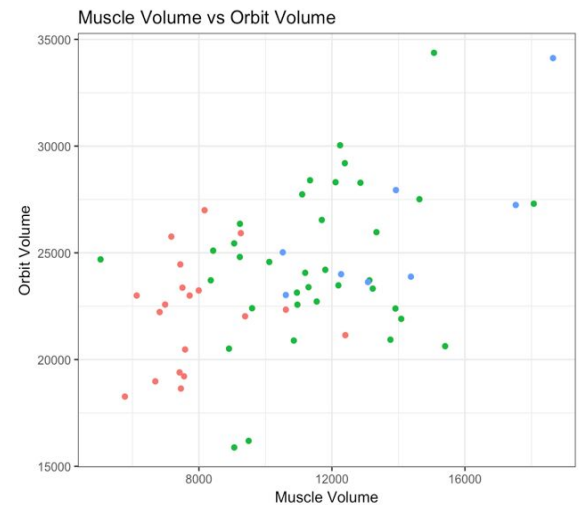
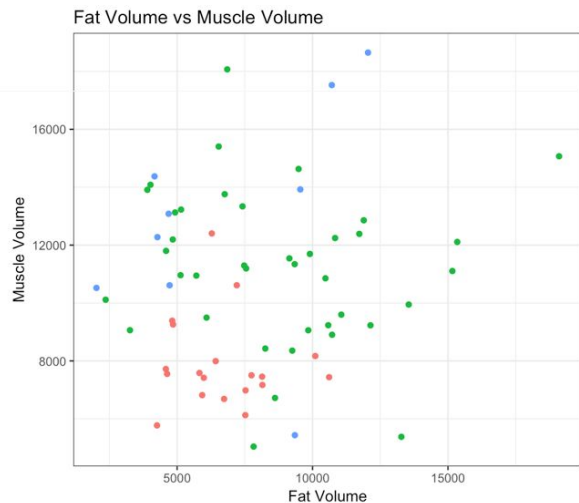
|   |                   |
|---|-------------------|
| CAS Score                                 | type= numeric     |
| OSDI Score                                | type= numeric     |
| Lagophthalmos (left and right )           | type= numeric     |
| Decompression (left and right)            | type= categorical |
| Hertel (left and right)                   | type= numeric     |
| Fat Vol/ Orbit Vol (left and right)       | type= numeric     |
| Muscle Vol/ Orbit Vol (left and right)    | type= numeric     |
| Medial Wall Bowing (left and right)       | type= categorical |
| Medial Rectus Muscle Vol (left and right) | type= numeric     |

# Additional Models

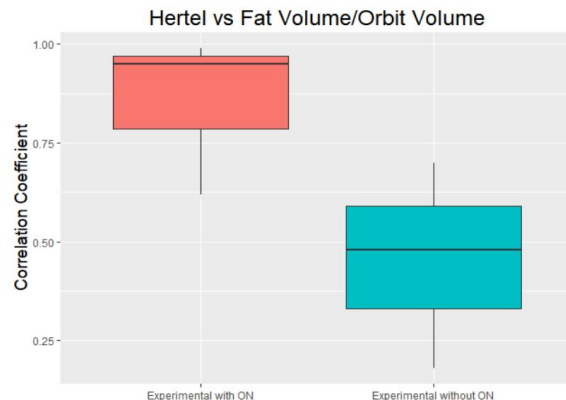
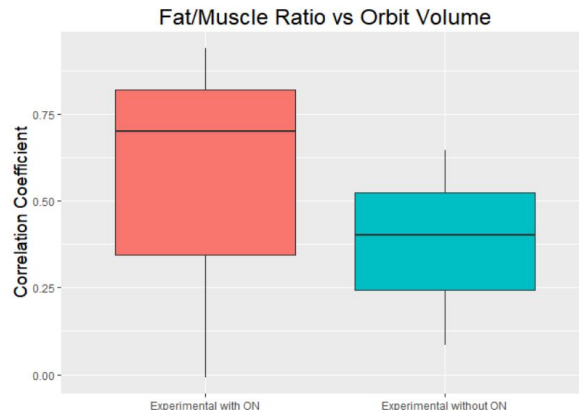
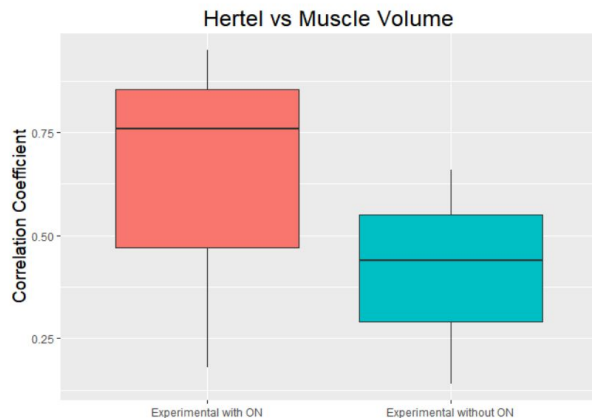
We also used a model fitted by penalized ML to do the same test. Again, there were no significant predictors.

# Post Presentation Additions

# Exploring Muscle, Fat, and Orbit Volumes



# Correlation Coefficient between Significant Variables in Experimental ON vs Experimental non-ON



Compares correlation coefficient of significant variables from scatterplots from last slide. In general, despite overlap, experimental with ON has a larger correlation coefficient than experimental without ON. The middle line is the estimated correlation coefficient and the ends of the tails are the 95% confidence interval.



# Comparison of Numerical Variables

| Variable      | ON=1    | ON=0     | Decompression | No Decompression | Strabismus | No Strabismus |
|---------------|---------|----------|---------------|------------------|------------|---------------|
| Lagophthalmos | 0.79    | 0.54     | 0.85***       | 0.3409***        | 0.55       | 0.607         |
| Hertel        | 22.22   | 22.07    | 23.05*        | 21.45*           | 21.71      | 22.65         |
| FV/OV         | 25.86*  | 34.02*   | 35.62         | 31.61            | 31.38      | 35.25         |
| MV/OV         | 51.35*  | 47.86*   | 49.29         | 47.47            | 49.86      | 45.92         |
| MV/FV         | 2.42*** | 1.601*** | 1.79          | 1.61             | 1.95*      | 1.481*        |

Thanks for listening!  
Questions?

# Appendix

# Predicting Decompression: no significant predictors

**Method:** Logistic Regression **Output:** Decompression Yes or No **Predictors:** In table below

|                          |                   |   |
|--------------------------|-------------------|---|
| CAS Score                | type= numeric     | range= 0 to 6                                 |
| OSDI Score               | type= numeric     | range= 4.167 to 100                           |
| Lagophthalmos            | type= numeric     | range= 0 to 2                                 |
| Strabismus               | type= categorical | 0= Not Present 1= Present                     |
| Hertel                   | type= numeric     | range= 11 to 40                               |
| Fat Vol/ Orbit Vol       | type= numeric     | range= 8.077 to 55.576                        |
| Muscle Vol/ Orbit Vol    | type= numeric     | range= 5041 to 18649                          |
| Medial Wall Bowing       | type= categorical | 0= not present 1= present                     |
| Medial Rectus Muscle Vol | type= numeric     | range= 649.8 to 4111.2<br>(48 missing values) |