RSG online program documentation

The Refractive Surgery Graphics (RSG) online program lets you upload an excel file that will be processed to show you several graphics that let you have a better idea about your outcomes from refractive surgery. It can also make the standard graphics to report outcomes and all the graphics can be downloaded as a PNG file to be used in your own reports or presentations.

Any data uploaded will be deleted from the server when you leave or reload the site.

The different parts of the program can be accessed from the tabs at the top of the screen:

Upload data

Note to NOG members (Dutch ophthalmology society):
It is possible to upload directly the excel file from the *kwaliteits registratie*. Log in kwaliteits registratie, click the *Landelijk Cataract Registratie NOG* or the *Registratie Refractiechirurgie* button and then the *Download eigen data* button. Open the excel and save it (you don't have to change anything but otherwise it will not upload to RSG). In the *File type* select box there is a default value: *Normal*, choose *NOG - Cataract* or *NOG - Refractie*, now you can upload it to RSG. The visus values are in decimal scale.

This tab will show the current data loaded on the server, by default there is a demo dataset with 100 eyes. At the top of the table you can click on the name of a variable to order the data in ascending order of the values of that column, clicking again will order them in descending order.

Let the *File type* select box in *Normal* and press the button to upload your excel file, your file has to meet some requirements:

- If you prefer, you can download the excel template. This is an excel file with a row with the name of the headers to get you started.
- The file has to have a **.xlsx** extension, remove any format in the cells before uploading.
- The file cannot exceed 20 Mb. Up to 100.000 rows will be read.
- The excel needs to have 20 columns (from A to T), extra columns will not be read. Only the first sheet will be read so be sure your data is there.

- The first row of the excel has to have the variable names, the names don't have to be the same as in the demo dataset but they will be changed into these names except for the last two columns that will be left as in the excel.

- It is very important to maintain the order of the variables like in the demo dataset. The order for the columns with the format of their values and the validation of the data performed is the following:

    1. **id:** Your identification of the patient. Numbers or characters.
    2. **age:** Age of the patient at the moment of the surgery. Number, if it's negative it will be converted to positive, empty cells or with characters in it will be considered as a *missing value* and that row will be deleted for graphics that take into account the age.
    3. **sph.pre:** Refractive sphere value pre-op. Number. Empty cells or with characters in it will be changed to 0.
    4. **cil.pre:** Refractive cilinder value pre-op. Number. Empty cells or with characters in it will be changed to 0.
    5. **axis.pre:** Axis of the cilinder pre-op. Number. Empty cells or with characters in it will be changed to 0. Negative values will be changed to positive, values larger than 180 will be changed to 180.
    6. **K1.pre:** Pre-op K value in diopters of a principal meridian. Number. Negative values will be changed to positive, values larger than 100 will be changed to 100.
    7. **K2.pre:** Pre-op K value in diopters of the other principal meridian. Number. Negative values will be changed to positive, values larger than 100 will be changed to 100.
    8. **axisK2.pre:** Principal meridian orientation of the **K2.pre** value. Number. Negative values will be changed to positive, values larger than 180 will be changed to 180.
    9. **cdva.pre:** Corrected distance visual acuity pre-op. See below note on visual acuities.
    10. **sph.post:** Refractive sphere value post-op. Number. Empty cells or with characters in it will be changed to 0.
    11. **cil.post:** Refractive cilinder value post-op. Number. Empty cells or with characters in it will be changed to 0.
    12. **axis.post:** Axis of the cilinder post-op. Number. Empty cells or with characters in it will be changed to 0. Negative values will be changed to positive, values larger than 180 will be changed to 180.
    13. **K1.post:** Pre-op K value in diopters of a principal meridian. Number. Negative values will be changed to positive, values larger than 100 will be changed to 100.
    14. **K2.post:** Pre-op K value in diopters of the other principal meridian. Number. Negative values will be changed to positive, values larger than 100 will be changed to 100.

15. **axisK2.post:** Principal meridian orientation of the **K2.post** value. Number. Negative values will be changed to positive, values larger than 180 will be changed to 180.
16. **target:** Aimed spherical equivalent (SE) value after surgery. Number. Empty cells or with characters in it will be changed to 0. Values will be rounded to the closest 0.25.
17. **udva.post:** Uncorrected distance visual acuity post-op. See below note on visual acuities.
18. **cdva.post:** Corrected distance visual acuity post-op. See below note on visual acuities.
19. **Custom name:** In this column you can put any factor you want (like sex, operator, complication, IOL type, etc). All characters will be made capital letters. You can leave all the cells empty but it has to have a header in the first row. See below in section **S.E. preop vs postop** for more details.
20. **Custom name:** Another factor as in 19.

All refractions with positive cilinder will be transposed to negative cilinder.

Note on visual acuities: When you upload an excel you can choose in which format is recorded in the excel:

- Decimal
- $20/x$ format, only the x will be in the excel.
- $6/x$ format, only the x will be in the excel.
- LogMAR

In all cases it must be a number, empty cells or with characters in it will be considered as a *missing value* and that row will be deleted for graphics that take into account the visual acuity.

If you checked the wrong format the graphics related to visual acuity will not be correct, you can solve this by clicking the right format afterwards and you don't have to upload the data again.

Under the data table there are two more tables, the first one shows how many missing values are per variable, the refraction and the target variables will never have missing values because of the validation performed on them. The second table shows the number of unique values in the last two columns. Under this table you can subset the data by one value in one or both custom factors by choosing them in the select boxes.

Distributions

- **Histograms and bar graphs:**
  Here you can find histograms for the values of the SE pre-op and post-op and the

ages and bar graphs for the two custom factors, if the custom factor has more than 15 different values then the histogram is not shown. You can check the *Make X tick labels short* widget at the right side if you have long names for the custom factors.

The histogram for the SE post-op values is shown only for the values with the target selected in the widget to the left where all unique target values are shown. Above the SE preop histogram you can see the number of eyes, mean SE preop and range, above the SE postop histogram you can find the number of eyes (N), the mean and the standard deviation SE for the chosen target.

- **Boxplots:**
  Here you can see boxplots for the SE postop by age category (25 or under, 26 to 40, 41 to 60 and over 60), each of the two custom factors and the combination of the two custom factors. For each of the boxplots for the custom factors the graphic will not be shown if there are more than 10 unique values for that factor, for the combined factors boxplot the graphic will not be shown if the sum of unique values for both factors is above 16. You can check the *Make X tick labels short* widget at the right side if you have long names for the custom factors.

  The results will be shown for the selected target SE. If you select *Independent* then the SE accuracy will be shown as SE attempted - SE achieved, this way it makes it independent of the target SE. Clicking on the checkbox *Switch groups for combination of custom factors* will change the groups in the last boxplot.

Under each graphic you can press the **Download graph** button to download any of the graphics.

S.E. preop vs postop

Here you can see two scatterplots, you can click and drag in the left scatterplot to make a square, the right scatterplot will zoom to that area. You can move the borders of the square to change the area shown or you can drag the square to show other area, clicking out of the square will reset it.

In the right scatterplot you can click on a point and under the graphs you will see the data for that point, if more points fall in the same place then all points will be shown, you can as well click and drag to make a square that will show all the points selected, under the table you can press the button to download the table as an excel file.

The scatterplot shows the SE preop vs SE postop. The dashed blue line shows the mean SE post-op for all the points seen in all the graphics. The dashed grey line shows the chosen SE target, if *Independent* was chosen then it will not appear. The points shown are only the ones selected with the left widgets:

- **Select S.E. target:** Select points for this target SE. Choosing *Independent* shows the SE accuracy shown as SE attempted - SE achieved, this way makes it independent of the target SE.

- **Select cilinder preop range:** Select points within a cilinder range pre-op.

The graphic shown can be changed with the following widgets:

- **Show linear regression line:** Check this to show the regression lines in all graphics shown. If you select *Independent* then the SE accuracy will be shown as SE attempted - SE achieved, this way it makes it independent of the target SE.
- **Colour points by:**
  - *Don't colour the points*
  - *Heatmap*: This option will show the density of the points, this can be useful when there are a lot of points to show and want to see where are the higher density areas, green is low density and red high density, the brighter the red the more dense.
  - *Patient age*: Colour the points by the following patient ages: 25 or under, 26 to 40, 41 to 60 and over 60.
  - *Change in CDVA*: Change in lines seen between corrected distance visual acuity (CDVA) pre-op and post-op.
- **Separate graphics by:** A new plot will show the data separated by the chosen factor, you can see by individual factor up to a maximum of 64 unique values for that factor shown in a matrix of up to 8 x 8, empty cells will be labeled as Missing data and counts as one value. You can see also the combination of both factors, the one with more unique values will be the rows and the other the columns. The graphic will show the data with a maximum of 10 x 8 unique values and you can also click on the widgets to change the target value, colour the points or change the preop cilinder value, subsetting the data this way may make appear this graphic even if it was not shown before because there were too many factor values or combination of factor values, the reason is that the subsetted data may have a smaller combination of factor values. Remember that the dashed blue line shows the mean SE post-op for all the points seen in all the graphics, so not for each individual panel.

The last widget shows the number of points displayed and the mean SE post-op for all of them.

Under each scatterplot you can press the **Download graph** button to download any of the graphics. The size of the multiple panels graphic will depend on the number of panels shown, it might be easier to see the downloaded graphic than the one shown on the screen.

Astigmatism graphics

The widget to the left called *Show data with cilinder* lets you choose to see the double angle plots, centroids and induced astigmatism with positive or negative values.

- **Refractive:**
  Here you can see two double angle plots, you can click and drag in the left scatterplot to make a square, the right scatterplot will zoom to that area. You can move the borders of the square to change the area shown or you can drag the square to show other area, clicking out of the square will reset it.

  A detailed explanation of the double angle plots can be found in this paper by J. T. Holladay.

  You can switch between pre-op and post-op data with the widget on the left but the rings for the amount of the astigmatism will be maintained. For the post-op data a new widget will appear to choose a cilinder range from the pre-op data to show only those points. You can choose to see the data as a heatmap, this will show high density points areas red and low density areas green. If the density difference is large the zones with lowest density will not appear in the map.

  At the bottom left you get the centroid value for the points in the graphic and the number of points shown. Below it you can see the mean induced astigmatism for all the points, not only for the selected range; this way if you put the corneal astigmatism instead of the refractive astigmatism in cil and axis preop and postop in the excel, you can get the mean corneal astigmatism induced.

  In the right scatterplot you can click on a point and under the graphs you will see the data for that point, if more points fall in the same place then all points will be shown, you can as well click and drag to make a square that will show all the points selected, under the table you can press the button to download the table as an excel file.

  Under each scatterplot you can press the **Download graph** button to download any of the graphics.

- **Corneal:**
  Here you can find the corneal Surgically Induced Astigmatism (SIA).

  With the left widget you can choose to see the astigmatism pre-op and post-op or the SIA for each eye.

  With the widget *Show points with pre-op corneal astigmatism* you can choose to see all the eyes or only the ones with a pre-op corneal astigmatism with the rule (WTR), against the rule (ATR) or oblique.

  If you choose *Show status pre-op and post-op* and you don't select any factor then the left graphic shows the corneal astigmatism pre-op and the right one shows the corneal post-op astigmatism. The red cross is the centroid value for each plot. To the left you get the mean SIA for the cornea and the SIA SD to check SIA consistency. The SIA SD is calculated as $\sqrt{\sigma_x \ \sigma_y}$ and is the radius of the circle with the same area as the ellipse with shape $a = \sigma_x$ and $b = \sigma_y$. If you choose to separate the graphics by factors then you see one graphic for every factor or combination of factors if you chose both. In these cases, in each graphic you see the centroid pre-op and post-op, so not individual cases. You can also see how many eyes are and what is the SIA and SIA SD for each factor. The same limitations as in *S.E. preop vs postop / Separate graphics* apply here for showing or not the graphic.

If you choose *Show SIA from (0,0)* you see the SIA of each eye. The red cross is the centroid value of the SIA and the grey ellipse has shape $a = \sigma_x$ and $b = \sigma_y$. If you choose to separate the graphics by factors instead of the ellipse you see the axis of the ellipse as a blue crosshair but the SIA SD is calculated as in the previous case. In this graphics you can click on a point and under the graph you will see the data for that point, if more points fall in the same place then all points will be shown, you can as well click and drag to make a square that will show all the points selected, under the table you can press the button to download the table as an excel file

Only eyes with complete keratometry data pre-op and post-op are shown and included in the calculations.

Under each graphic you can press the **Download graph** button to download any of the graphics.

Standard graphs for reporting outcomes

Here you can find the nine standard graphics for reporting outcomes of refractive surgery proposed by Reinstein and required when applicable by the *Journal of Refractive Surgery*, the *Journal of Cataract and Refractive Surgery* and *Cornea* for any manuscript submitted to these Journals. There are also four suggested graphics for further reporting of astigmatism outcomes. Note that the single angle polar plots are for graphical display purposes and should not be misinterpreted as having performed vector calculations in a 0 to 180 space. All calculations are made doubling the angle and performing vector analysis following the Alpins method.

The graphics are divided by visual acuities, SE and astigmatism graphics. Under the sub-tab *Astigmatism* you can find the required graphics and under the sub-tab *Astigmatism - Polar graphics* the suggested graphics.

Under the sub-tab *Download report* you can download all the standard graphics (except the polar graphics) and the coefficients as a report in pdf, you can also choose the title that will appear at the top of the report (optional) and add a text that will go in the first page before the coefficients.

For the cumulative visual acuity graphic the x label is created depending on which format you choose in the *Upload data* tab.

For the two graphics for change in lines in visual acuity, the difference is calculated as follows:

- For decimal and logMAR notation the visual acuities are rounded to the first decimal and every 0.1 difference counts as a line.
- For $20/x$ and for $6/x$ the visual acuity is first transformed to logMAR and then rounded to the first decimal, every 0.1 difference counts as a line.

For the safety index only the eyes with filled values of pre-op and post-op CDVA are taking into account. For the efficacy index only the eyes with filled values of CDVA pre-op and UCDVA post-op are taking into account.

For the attempted vs achieved SE you can choose which limits to show in the widget above the graphic. The intercept and the slope of the linear regression formula as well as the coefficient of determination (R^2) shown in the graphic are rounded to the third decimal.

Above the SE refraction accuracy you can find the total number of eyes, the mean and standard deviation of the accuracy error.

For the S.E. stability the data is not taken from the uploaded data, instead you have to give the time point in months (0 for preo-op), the mean S.E. with the S.D. and the number of eyes in the widget. In the graphic will appear the numer of eyes of the last row you gave.

For the Target Induced astigmatism (TIA) vector vs SIA vector, the TIA is calculated to achieve an astigmatism of magnitude 0. The rows with a preop cilinder value of 0 will not be taken into account for this graphics as well as for the angle of error graphic. The calculations for these two graphics are made doubling the astigmatisms angles and changing the astigmatism to cartesian coordinates to work with vectors.

The correction index (CI) and the index of success (IOS) is calculated for all the rows with a preop cilinder value different of 0 and the mean of the CI and the IOS is shown. The success of astigmatism surgery is (1 - IOS)x100, if the difference vector (DV) is equal or greater than the preop cilinder then the success of astigmatism surgery is 0%

More details can be found in this paper by N. A. Alpins.

Under each graphic you can press the **Download graph** button to download any of the graphics.

Documentation

This section.