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Changes in Macular Hole Morphology after Vitrectomy with Internal Limiting Membrane Peeling Assessed by Scanning Laser Tomography (Heidelberg Retina Tomograph)

Dynamika zmian morfologicznych plamki
w obrazie skaningowej tomografii laserowej
(Heidelberg Retina Tomograph) po usunięciu błony granicznej
wewnętrznej siatkówki u chorych z otworami w plamce

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Abstract

Background. Idiopathic macular hole causes progressive loss of vision. Vitrectomy with retinal internal limiting membrane (ILM) peeling is a well-known treatment modality. Ophthalmoscopy and stereo fundus photography are usually used for macula assessment. However these methods are subjective and do not provide quantitative assessment of the macula after vitrectomy.

Objectives. The aim of this study was to assess morphological changes in idiopathic macular hole after vitrectomy with ILM peeling using scanning laser tomography (Heidelberg Retina Tomograph).

Material and Methods. Fourteen eyes of 14 patients (3 men, 11 women) aged 62–79 years with idiopathic macular hole stage III or IV were included. Scanning laser tomography was performed before and two weeks to three months after vitrectomy. The macular hole was circumscribed with a circle corresponding to its edge. The parameters assessed were: area, mean radius, volume below the surface, effective mean depth, and maximum depth in contour.

Results. The mean area of the macular hole was 0.318 mm² (± 0.12) before and 0.319 mm² (± 0.11) after vitrectomy, mean radius was 0.313 mm (± 0.05) before and 0.314 mm (± 0.05) after vitrectomy, the differences not being statistically significant. The effective mean depth was 0.11 mm (± 0.06) before and 0.01 mm (± 0.01) after vitrectomy ($p < 0.001$), maximum depth in contour was 0.18 mm (± 0.06) before and 0.05 mm (± 0.02) after vitrectomy ($p < 0.0001$), and the volume below the surface was 0.029 mm (± 0.01) before and 0.004 mm (± 0.005) after vitrectomy ($p < 0.001$). The mean visual acuity before vitrectomy was 0.08 (± 0.04) and it improved to 0.24 (± 0.13) after surgery ($p < 0.001$). The change in visual acuity correlated with the change in volume below the surface ($p < 0.05$).

Conclusions. Scanning laser tomography is a useful tool for assessing macular hole morphology after vitrectomy (Adv Clin Exp Med 2007, 16, 1, 69–73).

Key words: scanning laser tomography, macular hole, vitrectomy

Streszczenie

Wprowadzenie. Otwory w plamce są częstą przyczyną postępującej utraty ostrości wzroku. Jedyną metodą leczenia otworu w plamce jest witektoomia z usunięciem błony granicznej wewnętrznej siatkówki. Do oceny stanu plamki po zabiegu stosuje się metody subiektywne (oglądanie dna oka, kolorowe zdjęcia dna oka), niepozwalające na ilościową analizę badanego obszaru.

Cel pracy. Analiza porównawcza stanu morfologicznego otworów w plamce przed, a następnie po zabiegu operacyjnym witektoomii z usunięciem błony granicznej wewnętrznej, dokonana za pomocą skaningowej tomografii laserowej (Heidelberg Retina Tomograph – HRT).

Materiał i metody. Do badań włączono 14 oczu dorosłych chorych (3 mężczyzn, 11 kobiet), w wieku od 62 do 79 lat, z idiopatycznym otworem w plamce w III lub IV stadium. Skaningową tomografię laserową centralnej siat-

kówki wykonano przed witrektomią, a następnie 2 tygodnie – 3 miesiące po operacji. Otwór plamki wpisywano w okrąg odpowiadający dokładnie brzegom otworu. Oceniano następujące wskaźniki otworu: powierzchnia (*area*), średni promień (*mean radius*), objętość pod powierzchnią (*volume below surface*), efektywna średnia głębokość (*effective mean depth*), maksymalna głębokość (*maximal depth in contour*).

Wyniki. Średnia powierzchnia otworu plamki (*area*) w badanej grupie chorych wynosiła średnio 0,318 mm² ($\pm 0,12$) przed witrektomią i 0,319 mm² ($\pm 0,11$) po witrektomii, średni promień powierzchni (*mean radius*) wynosił średnio 0,313 mm ($\pm 0,05$) przed witrektomią i 0,314 mm ($\pm 0,05$) po witrektomii, różnice były nieistotne statystycznie. Istotnie zmieniły się natomiast wskaźniki opisujące otwór plamki trójwymiarowo: średnia efektywna głębokość otworu (*effective mean depth*) wynosiła przed zabiegiem 0,11 mm ($\pm 0,06$), po zabiegu 0,01 mm ($\pm 0,01$), $p < 0,001$, maksymalna głębokość otworu (*maximum depth in contour*) przed zabiegiem osiągała średnio 0,18 mm ($\pm 0,06$), a po zabiegu 0,05 mm ($\pm 0,02$), $p < 0,0001$, objętość poniżej powierzchni (*volume below surface*) wynosiła przed zabiegiem średnio 0,029 mm ($\pm 0,01$), a po zabiegu 0,004 mm ($\pm 0,005$), $p < 0,001$. Średnia ostrość wzroku przed witrektomią wynosiła 0,08 ($\pm 0,04$), a po witrektomii uległa poprawie do 0,24 ($\pm 0,13$) ($p < 0,001$). Zmiana ostrości wzroku korelowała ze zmianą w objętości poniżej powierzchni (*volume below surface*), $p < 0,05$.

Wnioski. Skaningowa tomografia laserowa (HRT) jest obiektywnym narzędziem badawczym, pomocnym w ocenie topografii otworów plamki u pacjentów poddanych chirurgicznemu usunięciu błony granicznej wewnętrznej siatkówki (*Adv Clin Exp Med* 2007, 16, 1, 69–73).

Słowa kluczowe: skaningowa tomografia laserowa, otwór w plamce, witrektomia.

Idiopathic macular hole causes serious loss of vision in patients over 55 years of age. Vitrectomy is a well-known and established treatment modality which results in the release of tractional tangential forces causing elevation of the edges of the macular hole by peeling the internal limiting membrane (ILM) of the retina and SF6 tamponade [1, 2]. Anatomical success, described as the disappearance of subretinal fluid and flattening of the macular hole's edges, is achieved in 58–73% of cases [2–5]. The anatomical effect does not always correspond with functional success. Visual acuity improvement of at least two lines on the Snellen chart is achieved only in 42–56% of cases [2–5]. Ophthalmoscopy and stereo fundus photography are usually used for macula assessment. However, these methods are subjective and do not provide quantitative assessment of the macula after vitrectomy [6].

The aim of this study was to assess morphologic changes in idiopathic macular holes before and after vitrectomy with ILM peeling using scanning laser tomography (Heidelberg Retina Tomograph, HRT) and correlate these with visual acuity.

Methods

Fourteen eyes of 14 patients (3 men, 11 women) aged 62–79 with idiopathic macular hole stage III (5 eyes) or IV (9 eyes) were included. Vitrectomy with ILM peeling and SF6 tamponade was performed in all eyes between May 2003 and January 2004 at the Department of Ophthalmology in Wrocław, Poland. Indocyanine green or trypan blue were used to stain the internal limiting membrane. Eyes without macular hole closure after vitrectomy were excluded from the study.

Quantitative assessment of macular morphology was performed by scanning laser tomography using a Heidelberg Retina Tomograph (version 2.01) before and after vitrectomy and during follow-up examinations. The Heidelberg Retina Tomograph (HRT) is a confocal laser scanning system designed for the acquisition and analysis of three-dimensional images of the posterior segment. It enables the quantitative assessment of the topography of ocular structures and precise follow-up of topographic changes [7]. A two-dimensional image is an optical section at the focal plane. When the focal plane is moved and images at different depth locations are acquired, a series of optical section images is obtained which forms a layer-by-layer three-dimensional image of the three-dimensional object. Topographical images are computed from the acquired three-dimensional images, consisting of 256×256 individual height measurements, which are absolutely scaled for the individual eye and have a reproducibility of the height measurements of approximately 10 to 20 microns [8]. The Heidelberg Retina Tomograph system allows the acquisition of three-dimensional images and topographic analysis of the macula. In particular, laser scanning tomography as realized in the HRT allows a quantitative assessment of changes in the morphology of the macula region over time [9–12].

Scanning laser tomography was performed before (Fig. 1) and two weeks to three months after vitrectomy (Fig. 2). In order to increase reproducibility and minimize the influence of artifacts, five single measurements of possibly highest quality were saved and the mean was calculated. The examination was always performed by the same person and the results were masked for the other person performing the visual acuity exami-

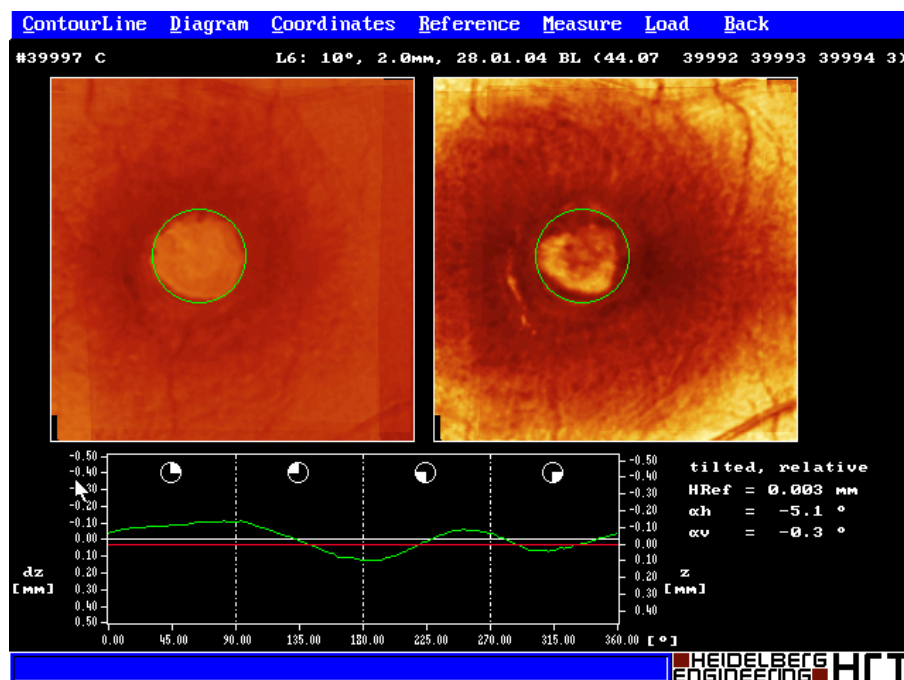


Fig. 1. Scanning laser topography of the macular hole before vitrectomy

Ryc. 1. Skaningowa tomografia laserowa otworu w plamce wykonana przed zabiegiem witrektomii

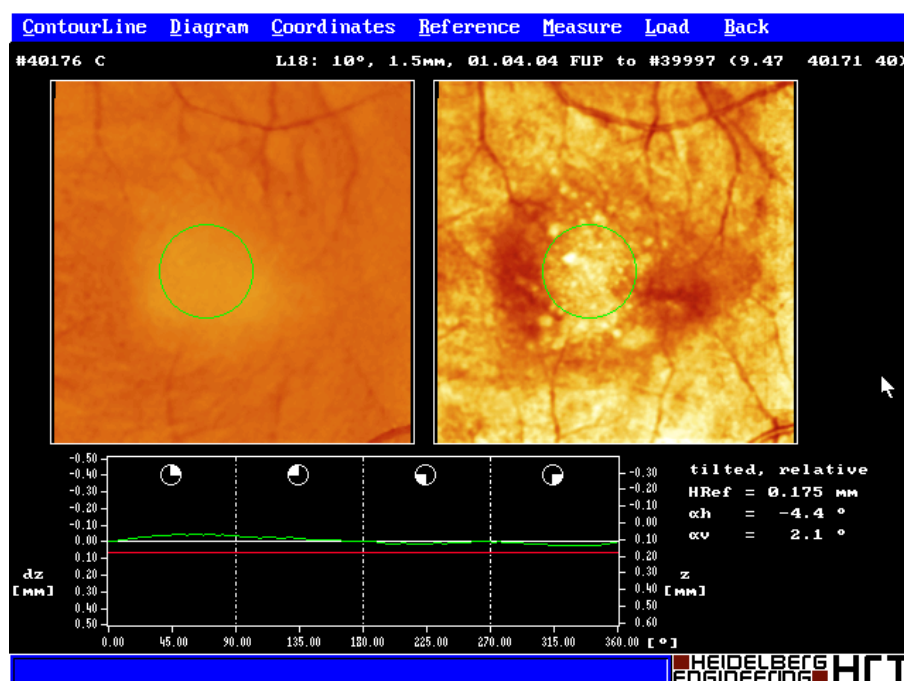


Fig. 2. Scanning laser topography of the same eye as in Figure 1 after successful vitrectomy

Ryc. 2. Skaningowa tomografia laserowa otworu w plamce oka przedstawionego na ryc. 1, wykonana po zabiegu witrektomii

nation. The macular hole was circumscribed with a circle (contour line) corresponding to its edge. The following parameters were assessed: area, mean radius, volume below the surface, effective mean depth, and maximum depth in contour. The contour line was then used for follow-up examinations using an export/import function.

All results are expressed as mean $\pm$ SD. The Wilcoxon matched-pairs signed-ranks test was used to compare values before and after vitrectomy. Spearman's rank correlation test was used to determine the relationship between values. A value of $p < 0.05$ was considered significant.

Results

The parameters describing the surface of the macular hole remained unchanged after vitrectomy. The mean area of the macular hole was 0.318 mm^2 (± 0.12) before and 0.319 mm^2 (± 0.11) after vitrectomy, mean radius was 0.313 mm (± 0.05) before and 0.314 mm (± 0.05) after vitrectomy, the differences not being statistically significant. Three-dimensional parameters changed significantly: the effective mean depth was 0.11 mm (± 0.06) before and 0.01 mm (± 0.01) after vitrectomy ($p < 0.001$) (Fig. 3), maximum depth in contour was 0.18 mm

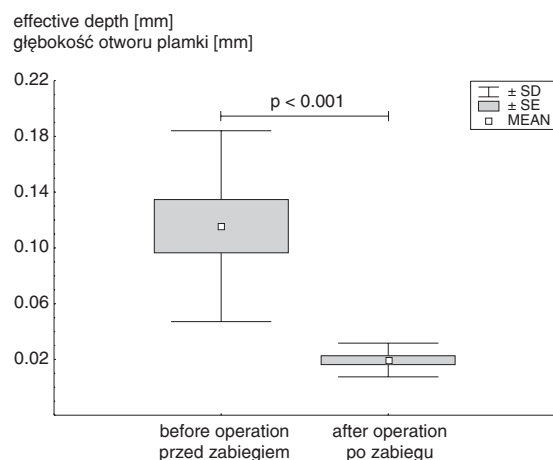


Fig. 3. “Effective depth” parameter of the macular hole before and after vitrectomy

Ryc. 3. Głębokość otworu plamki przed zabiegiem witrektomii i po zabiegu

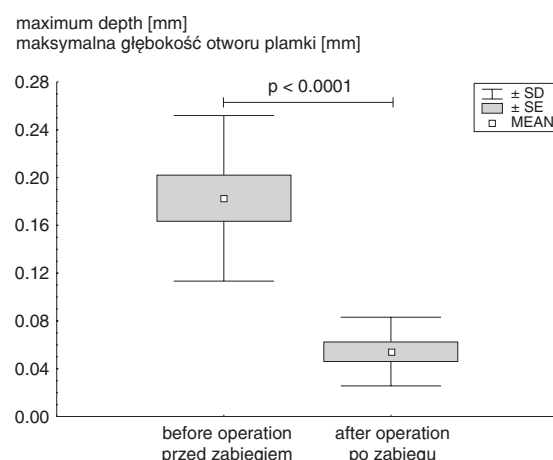


Fig. 4. “Maximum depth” parameter of the macular hole before and after vitrectomy

Ryc. 4. Maksymalna głębokość otworu plamki przed zabiegiem witrektomii i po nim

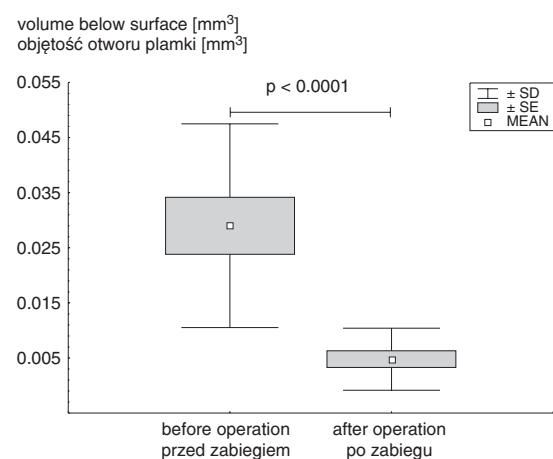


Fig. 5. “Volume below” parameter of the macular hole before and after vitrectomy

Ryc. 5. Objętość otworu plamki przed zabiegiem witrektomii i po nim

(± 0.06) before and 0.05 mm (± 0.02) after vitrectomy ($p < 0.0001$) (Fig. 4), and the volume below the surface was 0.029 mm (± 0.01) before and 0.004 mm (± 0.005) after vitrectomy ($p < 0.001$) (Fig. 5).

Discussion

Hudson et al. evaluated four eyes using HRT exhibiting different stages of macular hole formation preoperatively. The subjects were assessed preoperatively and at one and three months postoperatively. Topographic difference analysis of the right and left eyes of case 1 showed a significant postoperative reduction in the height of the retina. Topographic difference analysis of case 2 showed no significant change in topography. Topographic difference analysis of case 3 showed a significant postoperative increase in the height of the retina [13]. However the authors did not circumscribe the macular hole with a circle. Instead they analyzed images of the macula at 10-degree and 20-degree fields. Kobayashi et al. examined 44 Japanese patients with idiopathic full-thickness stage III macular holes in a similar follow-up period. They divided patients in two groups based on the size of the macular hole: $< 0.350 \text{ mm}^2$ and $> 0.350 \text{ mm}^2$. The area, volume, mean depth, and maximum depth of the macular holes diminished significantly postoperatively [14].

In the group of patients of the present study, the preoperative mean visual acuity was 0.08 (± 0.04) and improved after vitrectomy up to a mean of 0.24 (± 0.13), which was statistically significant ($p < 0.001$). The improvement in visual acuity correlated with the change in volume below the surface ($r = 0.99$, $p < 0.05$). Kobayashi et al. reported similar results [14, 15], additionally showing strong correlation of pre-op visual acuity with parameters describing the mean and maximal depth of the macular hole. This was not confirmed in our group of patients, probably due to the small number of cases.

Analyzing ten consecutive patients with macular holes, Byhr and Lindblom [16] suggested that the preoperative size of a macular hole can be used as a predictor of the functional outcome of macular hole surgery. Such a correlation was not observed in the group of patients of the present study. Studies of larger sample size are required to verify the predictive value of this parameter.

Scanning laser tomography (HRT) is an objective diagnostic tool for assessing macular hole topography in patients undergoing surgical removal of the retinal internal limiting membrane. Further studies on a larger group of patients with different stages of macular hole are needed to determine the correlation of stage with post-op visual acuity.

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