The Role of the Compression of Great Cervical Vessels by Thyroid Nodules in Eye Hydrodynamics Change

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The aim of the investigation was to reveal the changes in the indices of the outflow and secretion of aqueous humor in patients with great cervical vessels compressed by thyroid nodules to assess the compression effect on eye hydrodynamics and glaucoma development.

Materials and Methods. Eye hydrodynamics was studied in 60 patients (119 eyes) with the compression of great cervical vessels by uni- and bilateral benign thyroid nodules confirmed by neck duplex scanning and multispiral computed tomography.

Results. The majority of patients with the compression of great cervical vessels by thyroid nodules showed significant deterioration in aqueous humor outflow and production. After decompression the improvement and normalization of the eye hydrodynamics was observed.

Conclusion. Compression of great cervical vessels by thyroid nodules leads to the difficulty of aqueous humor passage from the eye, and is a risk factor of secondary phlebohypertensive glaucoma.

Key words: hydrodynamics of eye; aqueous humor; glaucoma; tonometric tests; compression of great cervical vessels.

Until now, glaucoma risk factors, etiology and pathogenesis still remain debatable. The key point of glaucoma pathogenesis is the disturbance of aqueous humor outflow via an eye drainage system, and the difficulty in aqueous humor outflow via episcleral veins results in the development of secondary phlebohypertensive glaucoma. The main causes of glaucoma are arteriolovenose anomalies (Sturge–Weber syndrome, carotid-cavernous fistula, orbital varicosity), the conditions leading to orbital venous compression (endocrine ophthalmopathy, retrobulbar tumors, vasculitis of orbital veins), superior mediastinal syndrome (superior vena cava compression) [1–5]. Difficulty in aqueous humor outflow via episcleral veins is the key point of the disease pathogenesis, and results in secondary phlebohypertensive glaucoma. Currently, the effect of the compression of great cervical vessels (internal jugular veins and common carotid arteries) on the eye hydrodynamics parameters is unstudied. However, the solution of the problem is of great practical and scientific interest especially considering high frequency of thyroid pathology leading to the compression of the above mentioned vessels [6, 7].

The aim of the investigation was to study the parameters of aqueous humor outflow and secretion in patients with great cervical vessels compressed by thyroid nodules in order to assess the compression effect on eye hydrodynamics and glaucoma development.

Materials and Methods. The study involved 60 patients aged from 17 to 74 years with uni- and bilateral benign thyroid neoplasms (confirmed by preoperative fine-needle aspiration). The past history duration was from a year to 60 years. On ultrasound evidence, thyroid volume was 13–296 cm^3 (III–V thyroid enlargement degree according to Nikolaev). 51 patients were found to have bilateral nodes, and 9 patients had unilateral nodes. All patients were in an euthyroid state. The exclusion criterion was endocrine ophthalmopathy. The patients were examined preoperatively and 7 days after decompression.

In addition to standard and routine methods, the ophthalmological examination of the patients (119 eyes) included tonometric tests (Schiotz tonometer) using an electrotonometer GlauTest-60 (Russia). We determined the aqueous humor outflow parameters, i.e. outflow easiness coefficient (C, mm^3/min), Becker's coefficient (BC, mm Hg/mm^3/min) and the indices of aqueous humor secretion (F — minute volume, mm^3/min).

The state of great cervical vessels and the presence

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of their compression (in a greater degree, the internal jugular vein) was assessed by duplex scanning using an ultrasound scanner Philips-HD 11 XL (Netherlands) with a 5–9 MHz linear array probe, and contrast multispiral computed tomography (MSCT).

The compression of great cervical vessels by bilateral thyroid nodules was corrected by thyroidectomy, and in case of unilateral nodules, hemithyroidectomy was performed.

The study was carried out in accordance with the declaration of Helsinki (adopted in June, 1964 (Helsinki, Finland) and revised in October, 2000 (Edinburg, Scotland)) and approved by the Ethics Committee of Nizhny Novgorod State Medical University. All patients gave their written informed consent.

The findings were statistically processed using a software program Statistica 11.0.

Results and Discussion. The preoperative assessment of eye hydrodynamic indices demonstrated the following: 21 patients (26 eyes) appeared to have significant deterioration of aqueous humor outflow indices compared to the norm in the form of a reduced coefficient C (C=0.106±0.04 mm^3/min, norm: 0.14–0.56 mm^3/min) and increased BC (BC=192±127 mm Hg/mm^3/min, norm: 30–100 mm Hg/mm^3/min). Among them, 5 patients with bilateral compression of internal jugular veins according to duplex scanning findings of neck vessels had a reduced C coefficient, and BC of both eyes was increased; in other 16 patients such changes of parameters were recorded in an eye of the corresponding side of the compressed jugular vein indicating the difficulty of aqueous humor outflow from the eye through a drainage system due to the venous component resulting from extravascular compression of the internal jugular vein.

9 patients of 60 (13 eyes) had an increased BC (on the compressed side of internal jugular vein) above normal, if C is below 0.20 mm^3/min (from 0.15 to 0.2 mm^3/min) that is the manifestation of unstable compensation and a prerequisite to ophthalmohypertension. The outflow functions in other cases (n=30, 60 eyes) were within the normal range.

30 patients with previously diagnosed hindered aqueous humor passage after decompression of great cervical vessels showed the significant improvement of C (C=0.24±0.09 mm^3/min) and BC values (BC=86±32 mm Hg/mm^3/min). Moreover, the average values were achieved in most cases: C coefficient in 19 patients (23 eyes) and BC in 21 patients (30 eyes). It can be due to the alleviated aqueous humor passage from the eye in a drainage system resulted from venous decompression, and confirmed by repeated neck MSCT and duplex scanning findings. In addition, 30 patients with initially normal C and BC indices (n=30, 59 eyes) demonstrated the improvement of aqueous humor outflow parameters; it indicates the importance of the decompression of great cervical vessels.

The preoperative assessment of aqueous humor secretion indices in all patients with uni- and bilateral compression of great cervical vessels reveled aqueous humor secretion decrease (norm: 1.5–4.5 mm^3/min) in one or both eyes (more mexpressed on the side corresponding to the compressed cervical vessels). 35 patients (42 eyes) had significant preoperative aqueous humor hyposecretion: less than 1 mm^3/min; and its level in other 25 patients (47 eyes) appeared to be less than 2 mm^3/min indicating the inhibited intraocular fluid production. Normal secretion indices were found in patients with unilateral compression of great cervical vessels, on the side opposite to the affected one. All patients with aqueous humor production failure were found to have its significant production improvement after extravascular compression of common carotid arteries and internal jugular veins. Apparently, the secretion increase was due to the improved eye perfusion and decreased total peripheral vascular resistance. All changes of eye hydrodynamics changes are statistically significant ($p<0.05$) (See the Table).

The obtained data on eye hydrodynamics correlate to those of duplex scanning and MSCT of neck vessels indicating the presence of uni- and bilateral extravascular compression of internal jugular veins (in all 60 patients) and common carotid arteries (in 33 patients) by thyroid nodules with the changes of their shape and hemodynamic rate parameters before the surgery (Figure 1 (a) and 2 (a)). In most cases we observed

Eye hydrodynamics parameters in patients with the compression of great cervical vessels before and after surgery

Tonometric parameters	Hydrodynamics			
	OD		OS	
	Cervical vessels under compression	After decompression of cervical vessels	Cervical vessels under compression	After decompression of cervical vessels
True intraocular pressure (mm Hg)	17.0±2.79	18.0±3.46	17.0±2.49	17.0±2.50
Aqueous humor volume (mm^3/min)	1.50±0.94	2.2±1.11	1.20±4.31	1.80±3.05
Outflow easiness coefficient (mm^3/min)	0.21±0.09	0.27±0.08	0.20±0.09	0.27±0.08
Becker's coefficient (mm Hg/mm^3/min)	78.0±35.99	65.0±23.79	80.50±108.96	68.0±31.18

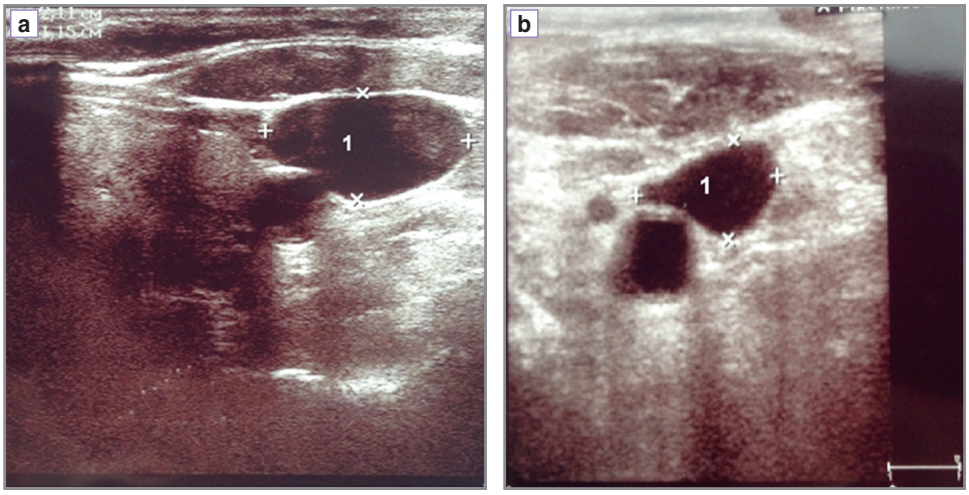

Figure 1. Patient P., neck duplex scanning before (a) and after (b) the surgery (thyroidectomy); *1*: transverse section of the left internal jugular vein: (a) the vein is ovoid-shaped, 21×14 mm in size, the norm being 15×15 mm; (b) the vein dimensions decreased up to 12.8×8 mm, its ovoid shape being preserved

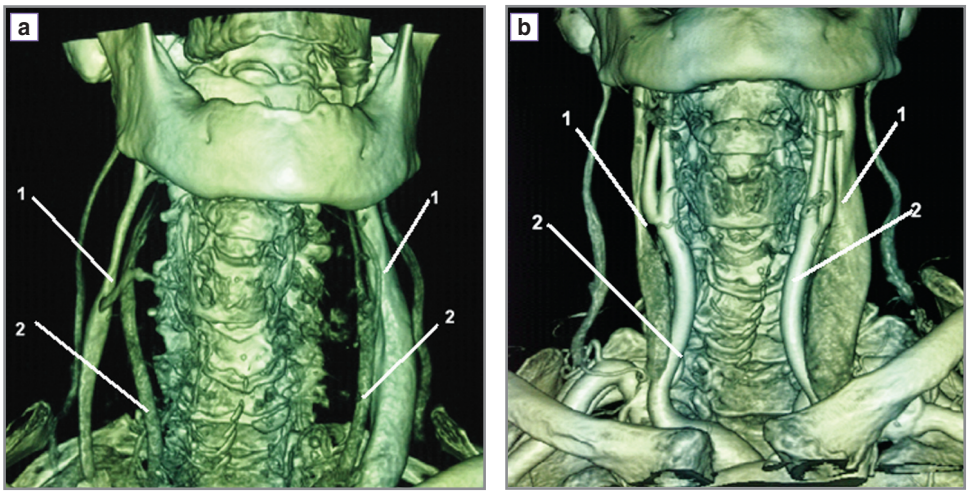

Figure 2. Patient P., multispiral computed tomography of cervical vessels before (a) and after (b) their decompression (*1*: internal jugular veins, *2*: common carotid arteries): (a) the vessels displaced to the outside acquired an arcual course; (b) the correct anatomical position of vessels is restored

the improvement in the form of corrected compression of great cervical vessels and their anatomical course restoration, the blood flow alignment throughout their course (Figure 1 (b) and 2 (b)).

Thus, the findings prove conclusively the negative influence of great cervical vessels compressed by thyroid nodules on eye hydrodynamics.

Conclusion. The compression of great cervical vessels by thyroid nodules results in the decline of difficulty of aqueous humor production and passage from the eye that is a risk factor of secondary vascular phlebohypertension and glaucoma. Surgical decompression of cervical vessels leads to the improvement and normalization of eye hydrodynamics parameters.

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References

1. Vassilieva A.E., Lutsevich E.E., Makashova N.V. Orbital and cranial venous blood flow in primary open-angle glaucoma. *Glaucoma* 2013; 3–1: 65–70.

2. Kurysheva N.I., Kiseleva T.N., Irtegova E.Yu. Venous ocular blood flow in primary open angle glaucoma. *Glaucoma* 2012; 4: 24–30.

3. Grieshaber M.C., Dubler B., Knodel C., Killer H.E., Flammer J., Orgül S. Retrobulbar blood flow in idiopathic dilated episcleral veins and glaucoma. *Klin Monbl Augenheilkd* 2007; 224(4): 320–323, http://dx.doi.org/10.1055/s-2007-962946.

4. Groh M.J., Küchle M. Idiopathic episcleral venous stasis with secondary open-angle glaucoma (Radius-Maumenee syndrome). *Klin Monbl Augenleilkd* 1997; 211(2): 131–132, http://dx.doi.org/10.1055/s-2008-1035110.

5. Moster M., Ichhpujani P. Episcleral venous pressure and glaucoma. *J Curr Glaucoma Pract* 2009; 3(1): 5–8, http://dx.doi.org/10.5005/jp-journals-10008-1002.

6. Ovchinnikov E.A., Maksimova I.Y., Agarkova D.I., Barskov A.N., Ovchinnikov V.A. Compression of great cervical vessels in nodular goiter as indication for thyroidectomy. *Sovremennye tehnologii v medicine* 2014; 6(3): 97–103.

7. Fadeyev V. Nodular goiter: controversial problems and negative tendencies in clinical practice. *Klinicheskaya i eksperimental'naya tireoidologiya* 2007; 3(2): 5–14.