Effects of unilateral internal jugular vein removal on intraocular pressure

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ABSTRACT

Purpose To investigate the intraocular pressure (IOP) and retinal nerve fibre layer (RNFL) thickness after ipsilateral neck dissection with internal jugular vein (IJV) removal for head and neck tumours.

Methods A computer search was performed to identify all patients who were treated with neck dissection with unilateral IJV removal from 2005 to 2012. All patients underwent a complete ophthalmological examination including measurement of IOP by Goldmann applanation tonometry and the average RNFL thickness using a Spectralis optical coherence tomography. The following analyses were made between the eyes on the side of the IJV removal versus the eye on the contralateral side: gonioscopy, IOP, vertical cup-disc ratio (VCDR) and peripapillary RNFL. Correlation analysis between the year of operation and IOP was done using the Pearson correlation coefficient.

Results This prospective cross-sectional study recruited 38 patients. The median age at operation was 59.5 years (range 33–87 years). There were 26 males and 12 females. Exactly half of the patients had left IJV removal and the remaining half had right IJV removal. The median interval from neck dissection to eye assessment was 46.5 months (range 11–97 months). There was no significant difference between the ipsilateral and contralateral side in terms of gonioscopy, IOP, VCDR, and RNFL. There was no significant correlation between the duration of IJV removal and IOP ($p=0.8$).

Conclusions Ipsilateral IJV removal after neck dissection did not result in any significant differences in the average peripapillary RNFL thickness or IOP compared to the contralateral eye at a mean of 46.5 months postoperatively.

INTRODUCTION

Intraocular pressure (IOP) remains one of the most important modifiable risk factors for glaucoma.[1] Accurate IOP measurement is essential for the diagnosis and monitoring of glaucoma. Following prolonged exposure to elevated IOP, irreversible glaucomatous optic neuropathy (GON) can occur resulting in peripheral visual field loss and visual impairment.

Various studies have shown that impaired venous return via the jugular vein can lead to elevation of IOP. Klein *et al*[2] have reported that bilateral compression of the jugular veins significantly increases IOP in dogs. In human trials, Teng *et al*[3] found that tightening a necktie for a mere 3 min was enough to significantly increase the IOP by 2.6±3.9 mm Hg in 70% of normal patients and increase the IOP by 1.0 ±1.8 mm Hg in 60% of glaucoma patients. Likewise, inflating a sphygmomanometer cuff around the neck to 40 mm Hg doubled the IOP.[4] Compression of the jugular vein causes an elevation of the episcleral venous pressure and an increase in episcleral venous pressure and choroidal vessel engorgement can increase the overall ocular volume and pressure.[5] Chronic ocular hypertension may subject the optic nerve to glaucomatous damage.

Neck dissection is commonly performed for various head and neck malignancies, including nasopharyngeal carcinoma, upper aerodigestive tract squamous cell carcinomas, thyroid malignancies, and oesophageal malignancies. Internal jugular vein (IJV) is one of the three non-lymphatic structures that are removed in radical neck dissection and in type II modified radical neck dissection. Few published studies have documented the effects of IJV removal on IOP. If the IJV removal chronically elevates IOP it can become a risk factor for the development of glaucoma, and further medical or surgical interventions may be warranted to prevent GON following IJV removal.

The aim of this study was to determine the effects of IJV removal on ipsilateral IOP and peripapillary retinal nerve fibre layer (RNFL).

METHODS

A computer search was performed to identify all patients who were treated with neck dissection under Division of Head and Neck Surgery, Department of Surgery, Queen Mary Hospital in Hong Kong Special Administrative Region, China, during the period from 2005 to 2012. This cross-sectional study included only patients with unilateral IJV removal. There were 77 patients with unilateral IJV removal during the study period. All were invited to participate in the study via telephone contact by a single investigator. Ten patients were deceased, two refused, and 20 could not be reached. The remaining 45 patients were referred to attend the clinic for informed consent and ophthalmological examination, but seven defaulted on the study enrolment day.

The exclusion criteria included: (1) residual space occupying neck lesions; (2) previous intraocular infection or inflammation; (3) corneal pathologies preventing accurate Goldmann applanation tonometry (GAT); (4) inability to sit upright for slit lamp examination; and (5) those with vascular reconstruction after IJV removal.

Before data collection, approval was obtained from the institutional review board of the University of Hong Kong and Hospital Authority. The study adhered to the Declaration of Helsinki. All eligible patients were invited to participate in the study. Consenting patients then underwent a complete ophthalmological examination by a single

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glaucoma specialist (JWL) who was masked from the laterality of the IJV removal when obtaining the following parameters: IOP measurement by GAT, gonioscopy, fundal exam for optic disc morphology and vertical cup-disc ratio (VCDR).

IOP was measured after instilling a drop of local anaesthetic with fluorescein stain under a blue filter light. The widest beam and brightest light was used on the slit lamp. The patient was instructed to focus straight ahead and a cotton applicator was gently used to lift up the upper lid where necessary. The tonometer head was advanced towards the eye and the calibrated dial was rotated until the two fluorescein semi-circles formed a horizontal 'S' shape. IOP was measured twice in both eyes per session over two sessions spaced 1 week apart. The average IOP in mm Hg was taken for each eye.

Gonioscopy was performed after instillation of a drop of local anaesthetic. A single mirror, indirect gonioscopy lens was filled with coupling gel before insertion into the eye. The room light was dimmed and a 10× magnification with a narrow and short (approximately 2–3 mm) beam was used on the slit lamp. The patient was instructed to look straight ahead. The superior angle was examined first and the gonioscopy lens was gently rotated 360° in a clockwise fashion until all four quadrants were examined and categorised based on the Shaffer angle grading system.[6]

The peripapillary RNFL thickness was measured using a Spectralis (Heidelberg Engineering, Carlsbad, California, USA) optical coherence tomography. Patients with an elevated IOP>21 mm Hg or abnormal investigations continued follow-up at the ophthalmology specialist clinic and anti-glaucoma treatment was initiated where appropriate.

Data were analysed with SPSS V.18.0 (SPSS, Inc, Chicago, Illinois, USA). Comparisons of various parameters between the ipsilateral and contralateral eye were performed with paired t test where appropriate. Correlation analysis was done using the Pearson correlation coefficient. A value of $p \leq 0.05$ was considered significant.

RESULTS

Thirty-eight patients were recruited. The median age at operation was 59.5 years (range 33–87 years). There were 26 males and 12 females. Exactly half of the patients had the left IJV removed and the remaining half had right IJV removal. All except one patient received adjuvant radiotherapy. The median interval from neck dissection to our eye assessment was 46.5 months (range 11–97 months).

The findings of gonioscopy, IOP, VCDR, and RNFL of both eyes have been summarised in table 1. The median Shaffer gonioscopy grades for both eyes were 3. Two eyes were pseudophakic, the rest were phakic. The mean angle grading in the two pseudophakic eyes (both grade 3) were not more open than the median grading of the study population (grade 3). Mean IOP for the ipsilateral and contralateral eyes were 13.8±2.8 mm Hg and 13.4±2.4 mm Hg, respectively. Compared to the contralateral side, the ipsilateral IOP was greater in 47.4% (18/38), the same in 13.2% (5/38), and less in 39.5% (15/38). None of the patients had IOP >21 mm Hg and none underwent anti-glaucoma treatment during the course of the study. Vertical cup-disc ratio was 0.3±0.08 in the ipsilateral eye and 0.3±0.1 in the contralateral eye. Average RNFL was 104.0±13.6 μm in the ipsilateral eye and 104.0±11.7 μm in the contralateral eye. No statistically significant differences were noted between the two eyes in all of the aforementioned parameters. There was also no significant correlation between the time from IJV removal versus IOP (p=0.8).

Table 1 Comparison of ophthalmological parameters in the eye with ipsilateral IJV removal versus the normal contralateral side

	Ipsilateral	Contralateral	Difference	p Value
Median gonioscopy grading (Shaffer grading)	3	3	0	0.7
Mean IOP (mm Hg)	13.8±2.8	13.4±2.4	0.4±1.9	0.2
Mean VCDR (ratio)	0.3±0.08	0.33±0.1	−0.01±0.07	0.4
Mean RNFL (μm)	104.0±13.6	104.0±11.7	0.0±7.1	0.9

IJV, internal jugular vein; IOP, intraocular pressure; RNFL, retinal nerve fibre layer; VCDR, vertical cup-disc ratio.

DISCUSSION

Neck dissection with removal of the IJV is often required during the surgical treatment for various head and neck malignancies. Vascular reconstruction for the IJV is not a routine practice. Previously, it has been reported that tightening a neck tie for a few minutes was enough to elevate the IOP via elevation of the episcleral venous pressure.[3 7] Hence the prolonged wearing of a tight neck tie was proposed as a potential risk factor for the development of glaucoma, although long term results of chronic tight neck tie wear were not available to validate the hypothesis.[3] Minas and Podos also described the Radius-Maumenee syndrome characterised by ocular injection and increased IOP from elevated episcleral venous pressure, eventually leading to glaucoma. [8]

To the best of our knowledge, this is one of the first studies investigating the effects on IOP and RNFL after IJV removal, and the results are clinically relevant to determine whether routine vascular reconstruction is warranted if unilateral IJV removal was found to be a risk factor for ocular hypertension or glaucoma. Unilateral IOP elevation secondary to a reduction in venous return to the heart has been demonstrated in a study by Barriga *et al*[9] whereby patients with cluster headache performed the Valsalva manoeuvre during an attack; it was found that the symptomatic side had a significantly greater IOP rise (4.1 mm Hg) than the asymptomatic side, and this increase was not associated with any pain or symptoms. In view of such evidence demonstrating a dramatic rise in IOP with tight neckties and Valsalva manoeuvres, we evaluated the hypothesis that IJV removal could potentially result in IOP elevation. However, at a mean of 46.5 months after IJV removal, we did not observe any significant difference in the IOP between the operated side (13.8±2.8 mm Hg) versus the normal contralateral side (13.4 ±2.4 mm Hg). In theory, however, autoregulation can bring down the IOP by either decreasing aqueous secretion or increasing aqueous outflow; therefore, we also investigated for differences in VCDR and RNFL that could have resulted from the periods of asymmetrical IOP elevation during the early postoperative period. There was, however, no significant difference between the ipsilateral (104.0±13.6 μm) and contralateral (104.0±11.7 μm) RNFL or VCDR (0.3±0.08 and 0.3±0.1 in the ipsilateral and contralateral eye, respectively). If autoregulation were to take place, we would have expected different IOP levels depending on the duration of time since the IJV removal. However, there was also no correlation between the time from IJV removal and IOP (p=0.8). Thus, it is possible that IOP changes may have occurred during the early postoperative periods and the later development of collaterals could have compensated for the loss of IJV, thereby mitigating long term IOP rises. Ensari *et al*[10] reported a case of bilateral ligation of

the internal and external jugular veins where digital subtraction angiography demonstrated the development of extensive venous collaterals to drain the bilateral sigmoid sinuses.

This study had its limitations. First, it would have been ideal to document the IOP before and immediately after the IJV removal to monitor for changes in the IOP in the early post-operative period; however, as many of these patients were critically ill or required intensive care support immediately after their neck dissection, measurement of GAT would have been difficult during this period. Secondly, this was only a single centre, cross-section study and all the measurements were only done by a single observer. But as the cross-sectional results at 46.5 months postoperatively did not reveal any significant IOP rise or RNFL thinning, the authors felt that the need for serial monitoring would be less relevant. Thirdly, the use of colour Doppler imaging of the orbit and neck would be useful to quantify any resistance to drainage and to detect for any collateral vessels. Fourthly, two cases had previous intraocular lens insertion which could have resulted in more open angles then the phakic eyes; however, as there were only two pseudophakic cases and both did not have angles that were more open than the median angle grading of the study population, their influence in this regard was negligible. Despite these shortcomings, this study has demonstrated that the average peripapillary RNFL thickness and IOP does not seem to differ between eyes as assessed at a mean of 46.5 months after unilateral IJV removal.

Contributors This study represents the original work of all the authors. All authors participated in the conception and design; data acquisition, analysis, and interpretation; as well as the drafting, revising, and approval of the manuscript.

Competing interests None.

Patient consent Obtained.

Ethics approval Study approved by the institutional review board of the University of Hong Kong and Hospital Authority.

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