

## Aeromedical Decision Making in Internal Jugular Phlebectasia

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- BACKGROUND:** Internal jugular phlebectasia (IJP) is an uncommon entity with only about 100 reported cases and with very few available cases in the literature. The current case study is about a male trainee fighter pilot incidentally diagnosed to have IJP. With limited literary evidence, it was a complex task to predict the prognosis of IJP and its implications on fighter flying.
- CASE REPORT:** In order to confirm the diagnosis, a preliminary study was carried out to find out the normal and expanded area of the internal jugular vein (IJV) of 30 volunteers. The expanded area of the right IJV of the trainee pilot fell beyond 1 SD of the study population, confirming the diagnosis of IJP in the trainee pilot.
- DISCUSSION:** Aeromedical concerns were the anti-G straining maneuver, positive pressure breathing for G, negative G<sub>z</sub>, modified Valsalva maneuver, and rapid decompression. Considering the potential progression of IJP by repeated exposure to aviation stresses, the trainee pilot was re-assigned to helicopters.
- KEYWORDS:** internal jugular phlebectasia, internal jugular vein, aeromedical, anti-G straining maneuver, positive pressure breathing, Valsalva maneuver.

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Internal jugular phlebectasia (IJP) usually presents as a soft, nonpulsatile and nontender mass in the supraclavicular area along the anterior border of the sternocleidomastoid muscle. The characteristic of the mass is enlargement in size during an increase in intrathoracic pressure.<sup>7</sup> This is because central venous pressure is directly proportional to intrathoracic pressure.<sup>2</sup> The other possible differential diagnoses for a neck mass are laryngocele, branchial cyst, cystic hygroma, cavernous hemangioma, superior mediastinal cyst, dermoid cyst, enlargement of the thyroid gland, substernal thyroid, cervical adenitis, and inflation of the pulmonary apical bullae.<sup>5</sup> The diagnostic modalities include ultrasonography, color Doppler flow imaging, and contrast enhanced computed tomography. Since the swelling is benign and appears only during straining, the likelihood of under-reported cases is quite probable. The complexity of the diagnosis of IJP is due to lack of defined criteria, insufficient cases, under-diagnosed cases, and scanty literature. With limited experience of IJP and the compound environment of the cockpit, it is difficult to predict the prognosis and implications in fighter flying. The case mentioned here is that of a trainee fighter pilot diagnosed with IJP, his subsequent evaluation, and the aeromedical decision making.

### CASE REPORT

A 22-yr-old male trainee pilot was undergoing Stage III operational fighter flying training and had accumulated 200 h of flying experience. During the training period, he was routed to the Institute of Aerospace Medicine for Operational Training in Aerospace Medicine. The training constitutes a gradual onset run, 4.5-G target tracking (TT), 6-G TT, 7-G TT, 8-G TT, and 9-G TT.<sup>4</sup> A swelling was noticed just above the right supraclavicular notch while the trainee pilot was practicing the anti-G straining maneuver. The trainee pilot did not offer any other complaint pertaining to the swelling. On examination, there was no swelling in front of the neck. However, the swelling appeared in front of the neck while performing the Valsalva

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maneuver and disappeared as soon as the pilot stopped doing the maneuver. The swelling was noticed more toward the right side above the supraclavicular notch. It was nonpulsatile, nontender, and compressible. The pilot was evaluated with a provisional diagnosis of substernal thyroid. Ultrasonography of the neck was normal; however, there was a significant increase in the area to the right of the internal jugular vein (IJV) while performing the Valsalva maneuver, as shown in **Table I**. Color Doppler flow imaging revealed a dilated right IJV with normal blood flow and velocity. Contrast enhanced computed tomography revealed mild prominence of the inferior end of the right IJV.

The dilemma was whether to continue or to stop the training of the pilot. The trainee pilot had accumulated 200 h of flying experience and this was his first exposure to the anti-G straining maneuver, a maneuver he would perform repeatedly in his career. Since there were no such reported cases in an aviator in the past and considering the nature of the findings, the prognosis of the condition was difficult to predict. Hence a drastic step like re-assigning the pilot to a different aircraft was not recommended initially. Keeping in mind the rare complications in such cases, the decision to continue his training was taken along with relevant investigations, review of the literature, and consultation with appropriate specialists. The trainee pilot was exposed to 9-G TT only when it was absolutely certain that such an exposure would not cause any harm to him immediately. The likelihood of probable problems, if any, would only increase with repeated exposure. The trainee pilot completed the course successfully.

Since no established diagnostic criteria was available for the Indian population, data was collected to find out the normal area and expansion of IJV during the Valsalva maneuver for the Indian population. The protocol for the study was approved by the ethics committee of the Institute of Aerospace Medicine. The study was carried out to measure the area of the IJV of 30 volunteers after informed consent. Healthy male volunteers in the age group 21 to 45 yr participated in the study. The volunteers were chosen randomly from the personnel posted at the Institute of Aerospace Medicine and represented a random population from India. The participants were taught the Valsalva maneuver by a single aerospace medicine specialist and they practiced the maneuver in front of the aerospace medicine specialist. Instead of diameter in the perpendicular axis, the area was measured since it was a more accurate measurement of a vessel. A radiologist measured the area of the IJV at two levels (the upper level of the thyroid cartilage and at the level of the sternoclavicular joint) on two different occasions (resting and Valsalva) in the supine position. The values are given in

**Table II**. Right IJV parameters for the index case fell beyond 1 SD of the study population. Since the above mentioned pilot had clinical findings of right IJP with collaborative ultrasonography findings, the diagnosis of right IJP was confirmed.

## DISCUSSION

The aeromedical concerns in IJP are the anti-G straining maneuver, positive pressure breathing for G, negative  $G_z$ , modified Valsalva maneuver, and rapid decompression. The anti-G straining maneuver involves forced exhalation against a completely closed glottis with straining of limbs and abdominal muscles. The exhalation (increased intrathoracic pressure) is maintained for 3–4 s and is interspersed with rapid inspirations for less than 1 s duration. This process is repeated cyclically as a protective measure against positive  $G_z$ . The intrathoracic pressure generated by the forced expiration is transmitted directly to the heart and great vessels. This is added to the pressure generated by cardiac contraction, which provides an increased arterial pressure at eye level up to the magnitude of 100 mmHg. The effect of increased arterial pressure on IJP is explained below in detail.

The G protective benefits of positive pressure breathing are similar to those of the anti-G straining maneuver. Positive pressure breathing is the application of positive pressure by a regulator for the breathing gas throughout the respiratory cycle. This increases the intra-pulmonary pressure and increased intrapulmonary pressure is transmitted to the left ventricle and intrathoracic vessels, and results in an increase in systemic arterial pressure. Thus both the anti-G straining maneuver and positive pressure breathing might have an effect on progression of IJP by increasing central venous pressure.

The immediate hydrostatic effect of negative  $G_z$  is that it increases the vascular pressure in the regions above (anatomically) the heart and decreases it below the heart. Considering the effective length of the venous column is from the level of the diaphragm to that of the head, the venous pressure at eye level at  $-3 G_z$  rises to more than 100 mmHg.<sup>6</sup> The increase in pressure is sufficient enough to cause expansion of the IJV and might lead to progression of IJP.

Modified Valsalva maneuver is one of the accepted techniques to open the Eustachian tube by forceful expiration against a closed nose and mouth during rapid ascent and descent in altitude in flight.<sup>6</sup> Modified Valsalva maneuver increases intrathoracic pressure and may affect progression of IJP.

**Table I.** Ultrasonography Findings of IJV Areas of the Trainee Pilot.

	AREA RT IJV (IN cm <sup>2</sup> )	AREA LT IJV (IN cm <sup>2</sup> )
Inferior end (Resting)	1.21	0.28
Inferior end (Valsalva)	2.9	0.8
Superior end (Resting)	0.31	0.16
Superior end (Valsalva)	0.94	0.76

**Table II.** Ultrasonography Findings of IJV Areas of Volunteers.

	RT IJV		LT IJV	
	MEAN AREA IN cm <sup>2</sup>	SD	MEAN AREA IN cm <sup>2</sup>	SD
Inferior end (Resting)	0.66	0.44	0.44	0.18
Inferior end (Valsalva)	1.99	0.74	1.19	0.53
Superior end (Resting)	0.39	0.15	0.31	0.21
Superior end (Valsalva)	1.12	0.39	0.79	0.33

During decompression, there will be a sudden expansion of the gases inside the thoracic cavity. The condition can worsen if the glottis is closed during breath holding or swallowing or straining or due to the characteristics of breathing equipment in use at the time.<sup>6</sup> Thus, sudden increase in pressure under such circumstances might rupture the IJP due to the drastic increase in central venous pressure.

Another fact is that, since the pilot is aware of such a swelling appearing during the anti-G straining maneuver and that there are chances of increase in the size of the swelling in the long run, the pilot may not perform an effective anti-G straining maneuver while exposed to positive  $G_z$ . This may jeopardize flight safety because of the increased risk of almost loss of consciousness and G-induced loss of consciousness in midair.

Although IJP is a benign condition, there are controversies regarding disease progression and complications. Follow-up studies for 6 mo and 1 yr have revealed no change in size.<sup>3</sup> There has been only one reported case of a 41-yr-old woman showing slow progression of IJP over 3 yr and she had a history of blowing chullah.<sup>1</sup> The initial complications of IJP are a feeling of constriction, choking, discoloration, thrombosis, discomfort, and tongue pain. It can further progress to cessation of voice, hoarseness in phonation, progressive enlargement, difficulty in deglutition, dyspnea, venous hum or bruit, and a feeling of a foreign body in the throat. Intramural thrombus, spontaneous rupture, and congestive heart failure are rare complications, but cannot be ruled out while considering the prognosis of the disease for aircrew.<sup>2</sup> Although Thulasiraman has mentioned in his article that IJP is not known to progress rapidly and there have been no instances of spontaneous rupture or other serious complications, development of complications in the future cannot be negated completely.<sup>8</sup> Complications are rare, but progressive neck swelling may lead to symptoms and complications on repetitive exposures to the anti-G straining maneuver, positive pressure breathing for G, the modified Valsalva maneuver, and negative  $G_z$ . An additional concern is the risk of sudden incapacitation due to rupture of the swelling or intramural thrombus formation. Since no case of IJP has been acknowledged in a fighter aircrew and long-term follow-up has not been done to

date, the progression of the condition in fighter flying cannot be commented upon. Based on limited evidence and likelihood of progression by repeated exposure to aviation stresses, the decision was taken to re-assign the pilot to transport/helicopter. He has been flying Mi17 helicopters for the last 2 yr without any incidents and he has been followed up with ultrasonography of the neck annually and there are no findings suggestive of any progression of disease.

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