Great care for Central Queenslanders

Central Queensland Hospital and Health Service

TRACHEAL WEBBING

A Case Study

Presented by Christine Woods, Scientist

Clinical Measurements Department

Rockhampton Hospital

With assistance from

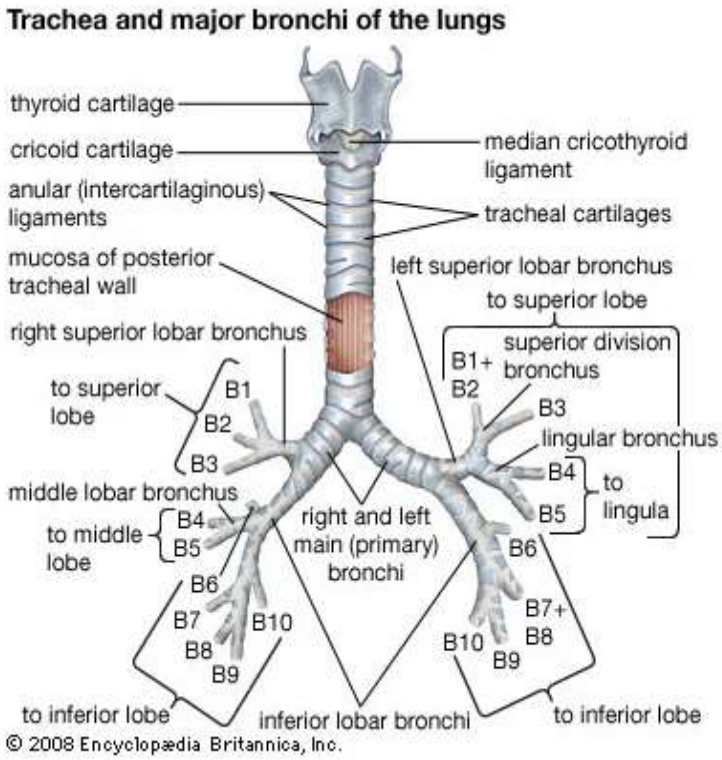
Jo Wex, Director CMD Rockhampton

Dr Kwun Fong, Thoracic Physician, TPCH

Queensland Government

Trachea

- Adult trachea extends from the inferior portion of the larynx to the branch point of the main carina
- Trachea is approx 10-16cm in length and 21-27mm in diameter
- The trachea is supported anteriorly and laterally by 15-20 C shaped cartilages which protect the integrity of the airway.
- Lies anterior to the oesophagus.
- Airflow is typically high velocity, turbulent flow. Driving pressure to achieve normal airflow rate is inversely proportional to the tracheal radius.
- Tracheal disorders result from intrinsic or extrinsic causes.



- Tracheal obstructions can be life-threatening as no alternative breathing pathways are available.

Des Jardins, T 2013; Al Qadi, M, Artenstein, A, Braman, S 2013,

Tracheal Webbing

- A tracheal web is formed when the thin layer of membranous tissue inside the trachea grows across the airway. It may contain small holes and have a spider web appearance (hence the name). The webbing narrows the lumen and causes a partial airway obstruction.
- Typically either congenital (1 in 10,000 births) or in adults the result of traumatic intubation (most common). Also known to occur from infections and inflammatory disorders.
- Symptoms include wheezing, dyspnoea, stridor, recurrent respiratory infections, and sometimes respiratory failure.
- Commonly misdiagnosed as refractory asthma or COPD.
- In some cases, may be asymptomatic (if mild obstruction) and only discovered when intubation is difficult.
- Bronchoscopy is the gold standard for diagnosing tracheal webs. Tracheal webs cannot be seen by routine visual inspection and is sometimes difficult to see in chest x-rays. CT scans tend to provide better visualisation of webs than x-rays.

Jafar, N, Islam, E, Alalawi, R 2015; Yin, Y & Zhang, L 2010

Treatment

- Depends on the age and severity of the case.
- In very young infants, the tracheal membrane can still be quite thin so the pressure of the bronchoscope may be sufficient to break webbing and clear the airway.
- Balloon dilation may be used to expand the area of narrowing.
- Surgical treatment.
- Electrocautery – Argon Plasma Coagulation was adapted for use in endoscopy in 1991 and has now become the most commonly used coagulation technique and is used for removal of tracheal webs.

Yin, Y & Zhang, L 2010; Zenker, M 2008

Argon Plasma Coagulation (APC)

- APC is a noncontact form of electrocautery that uses ionized argon gas (plasma) to conduct electrical current from the probe to the nearest grounded tissue.

- APC is a form of high frequency surgery and the term coagulation is used in electrosurgery to signify devitalisation of tissue and stanching of bleeding (haemostasis) through desiccation of the cells and denaturation of proteins.

- The high current density required to achieve the violent heating necessary for the cutting effect is generated by microsparks between the electrode and the tissue. To achieve the degree of coagulation at the borders of the cut, the current may be amplitude modulated.

- APC is particularly well suited for superficial treatments since the penetration depth of the coagulation is limited to a few millimetres.

Zenker, M 2008

Case Study Details

- 64 year old female, BMI 37kg/m^2 (obese), passive smoker, type 2 diabetic, presenting to GP with non-resolving, productive cough over 2-3 month period. Diagnosed with Bronchitis. Treated with 2 courses of anti-biotics with success.
- Over the next 12 months patient developed increasing shortness of breath, stridor with activities of daily living (ADL's) and at rest.
- GP introduced Flutiform (ICS/LABA) and Ventolin (SABA) with little to no improvement. Patient became non-compliant with the inhalers due to tremor following use and did not feel they were helping. Patient was compliant for some time before ceasing use.
- Shortness of breath, stridor continued to worsen.
- GP referred patient to Dr Kwun Fong, Thoracic Physician at The Prince Charles Hospital, Brisbane for investigation.
- February 2021 Dr Fong referred the patient to Rockhampton Hospital Clinical Measurements Department for complex RFT's as part of his investigation into what he described at the time as long term bronchospasm.

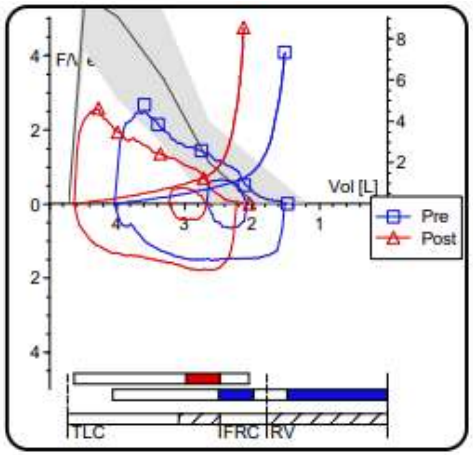
Centres for Disease Control and Prevention 2022

Initial Pre and Post Spirometry, DLCO Results

		Pred	LLN	Pre	%Pred	Post	%Pred	%Chg	Change (L)
Spirometry / Flow Volume									
FEV1	L	2.17	1.60	1.85	85.2	1.69	78.0	-8.5	-0.16
FVC	L	2.77	2.05	2.58	92.9	2.59	93.3	0.4	0.01
FEV1%F	%	78.68	65.73	71.75	91.2	65.41	83.1	-8.8	-6.34
MFEF	L/s	1.90	0.91	1.32	69.6	1.31	68.7	-1.4	-0.02
PEF	L/s	5.60	4.12	2.67	47.6	2.57	45.9	-3.7	-0.10
VBEex	L			0.05		0.04		-23.7	-0.01
FET	sec			7.34		8.54		16.4	1.21
VC IN	L	2.50	1.81	2.52	100.7	2.40	96.0	-4.6	-0.12
Slow Vital Capacity									
VC MAX	L	2.50	1.81	2.58	103.1	2.59	103.5	0.4	0.01
FEV1%M	%	78.68	65.73	71.75	91.2	65.41	83.1	-8.8	-6.34
PIF	L/s			1.82					

		Pred	LLN	Pre	% Ref
CO Transfer Factor					
DLCO_SB	ml/(min*mmHg)	20.73	15.00	21.09	101.7
DLCOcSB	ml/(min*mmHg)	20.73	15.00	20.78	100.2
VA	L	4.52	4.52	3.96	87.5
KCOc	ml/(min*mmHg*L)	4.44	2.89	5.25	118.3
VIN	L	2.50	1.81	2.46	98.4
TLC_SB	L	4.67	3.68	4.09	87.6

		Pre
Hb	g(Hb)/dL	13.90
%COHb	%	0.00



Patient struggled with technique due to airway sounding compromised at time of testing (significant stridor). Best efforts accepted in spirometry - these are repeatable. FVC to plateau. Flutiform, Ventolin ceased 3mths prior.

Interpretation

Moderate airflow obstruction with no evidence of reversibilty seen post ventolin. Preserved diffusion studies.

Please correlate.

CT Chest Images

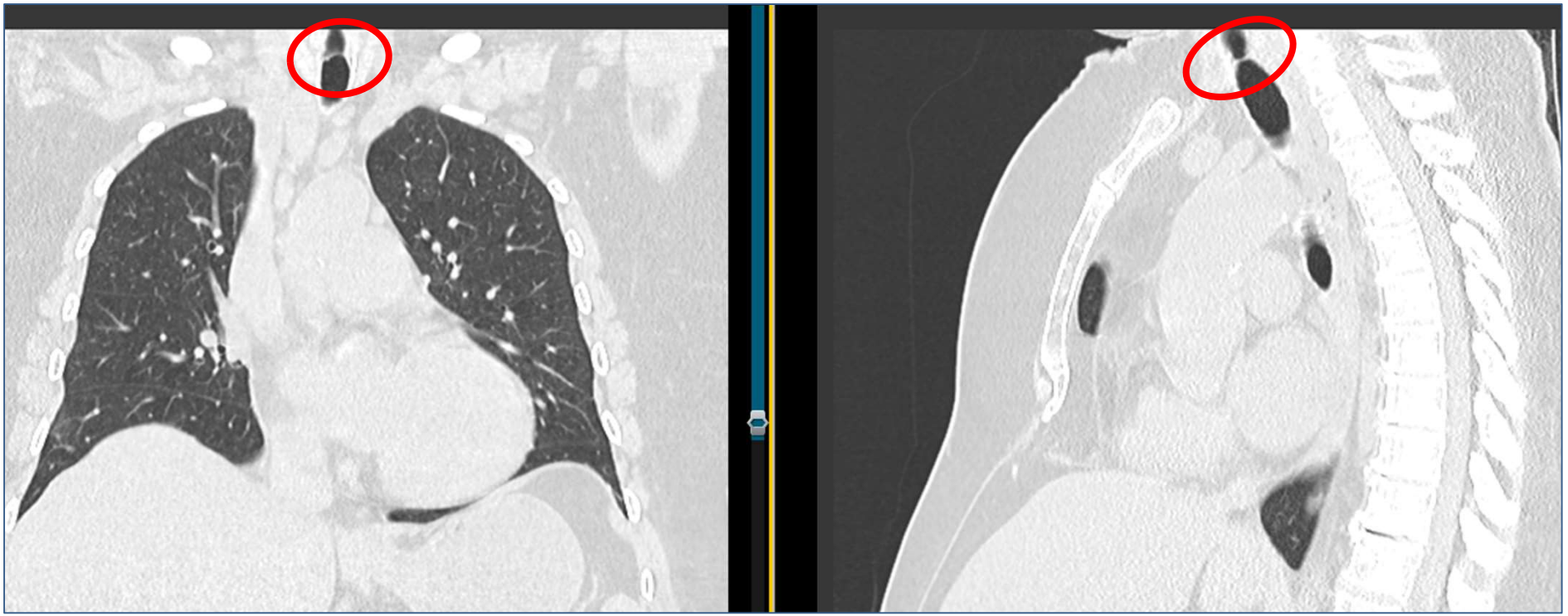
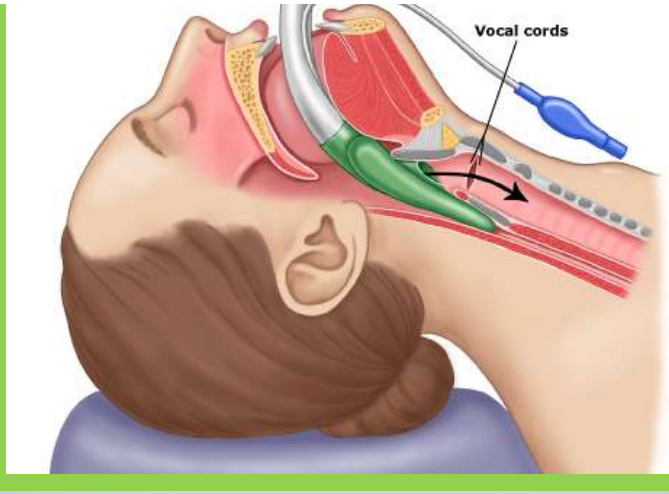


Image A – Coronal plane

Image B – Sagittal plane

Bronchoscopy with Argon Plasma Coagulation Performed by Dr Kwun Fong TPCH

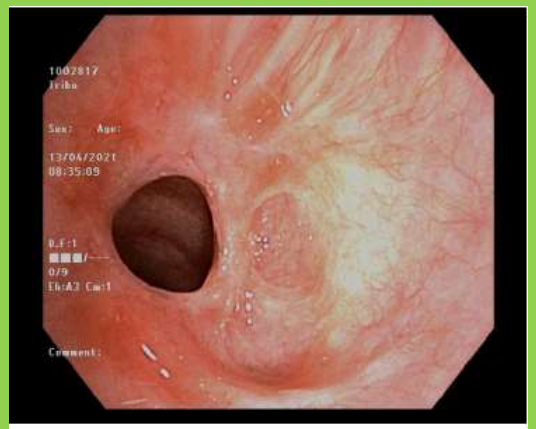


- Indications: Upper airway obstruction
- Medications: Lignocaine 2% (local anaesthetic) applied to cords 8mL. BF-1TH190 (EVIS EXERA III Bronchoscope) was introduced through the mouth, via laryngeal mask airway and advanced to the tracheobronchial tree of both lungs.
- Findings: Circumferential web causing 50% obstruction of upper airway 2cm below the cord.
- Treatment: Argon Plasma Coagulation with 40 watts pulse 0.8 flow radial cuts predominantly on the right side of the trachea, 2 pulse on the left with improvement in patency of the airway.

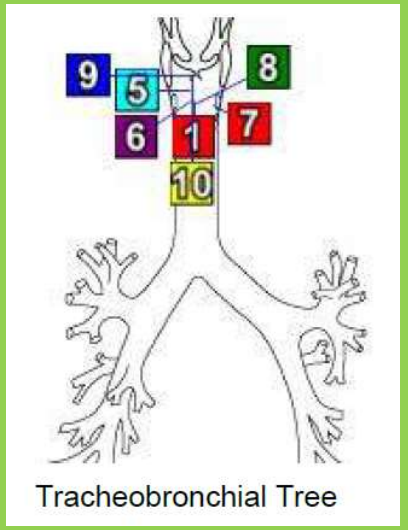
Bronchoscopy Images

BEFORE APC

5 Larynx

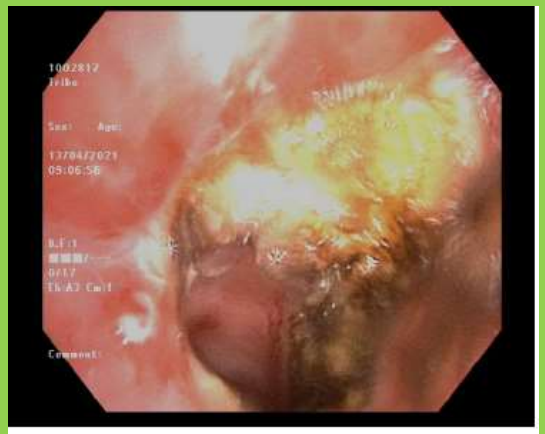


7 Subglottic tracheal wall



Tracheobronchial Tree

AFTER APC

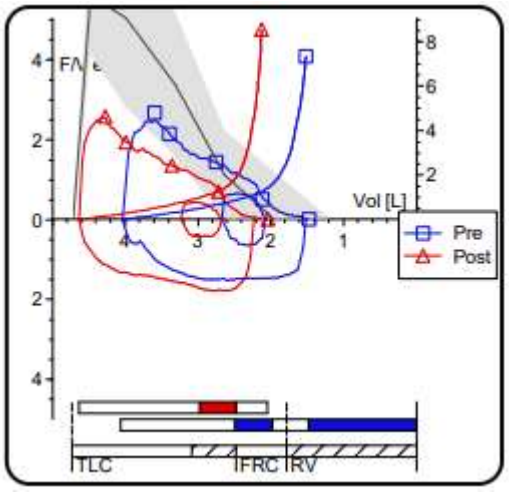


10 Larynx post

9 Larynx ; post

Test 1
2 months Pre Argon Plasma Coagulation

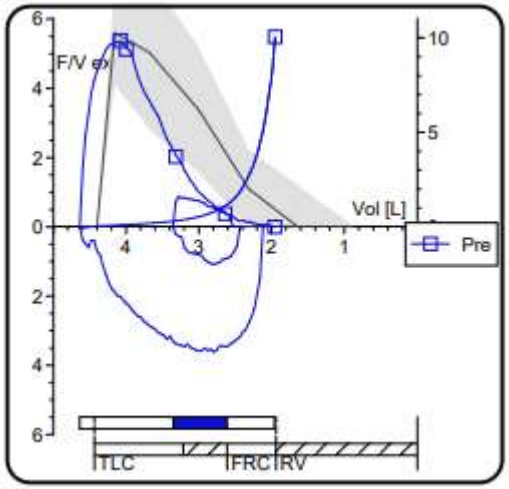
		Pred	LLN	Pre	%Pred
Level date				22.02.21	
Meas time				13:53	
Spirometry / Flow Volume					
FEV1	L	2.17	1.60	1.85	85.2
FVC	L	2.77	2.05	2.58	92.9
FEV1%F	%	78.68	65.73	71.75	91.2
MFEF	L/s	1.90	0.91	1.32	69.6
PEF	L/s	5.60	4.12	2.67	47.6
PIF	L/s			1.82	
Slow Vital Capacity					
VC IN	L	2.95	2.31	2.52	85.1
VC MAX	L	2.95	2.31	2.58	87.1
FEV1%M	%	78.68	65.73	71.75	91.2



Patient struggled with technique due to airway sounding compromised at time of testing (significant stidor). Best efforts accepted in spirometry - these are repeatable. FVC to plateau. Flutiform, Ventolin ceased 3mths prior.

Test 2
1 month Post Argon Plasma Coagulation

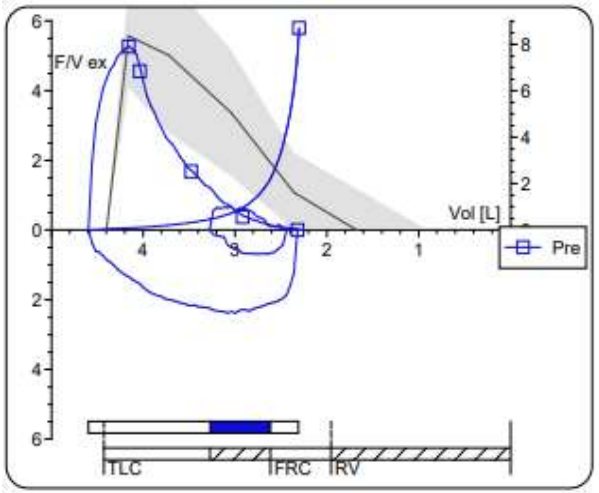
		Pred	LLN	Pre	%Pred
Level date				18.05.21	
Meas time				01:06PM	
Spirometry / Flow Volume					
FEV1	L	2.16	1.59	1.94	89.8
FVC	L	2.77	2.04	2.67	96.7
FEV1%F	%	78.65	65.67	72.60	92.3
MFEF	L/s	1.89	0.90	1.29	68.1
PEF	L/s	5.60	4.12	5.38	96.0
PIF	L/s			3.64	
Slow Vital Capacity					
VC IN	L	2.50	1.81	2.50	100.2
VC MAX	L	2.50	1.81	2.67	107.0
FEV1%M	%	78.65	65.67	72.60	92.3



Test performance was sound with repeatable efforts obtained, meets ATS. FVC to plateau. Nil bronchodilators.

Test 3
7 months Post Argon Plasma Coagulation

		Pred	LLN	Pre	%Pred
Level date				19.11.21	
Level time				02:39PM	
Spirometry / Flow Volume					
FEV1	L	2.15	1.58	1.69	78.7
FVC	L	2.75	2.02	2.29	83.2
FEV1%F	%	78.58	65.54	73.87	94.0
MFEF	L/s	1.88	0.89	1.20	63.8
PEF	L/s	5.57	4.09	5.27	94.6
PIF	L/s			2.65	
Slow Vital Capacity					
VC IN	L	2.47	1.78	2.27	91.9
VC MAX	L	2.47	1.78	2.29	92.5
FEV1%M	%	78.58	65.54	73.87	94.0

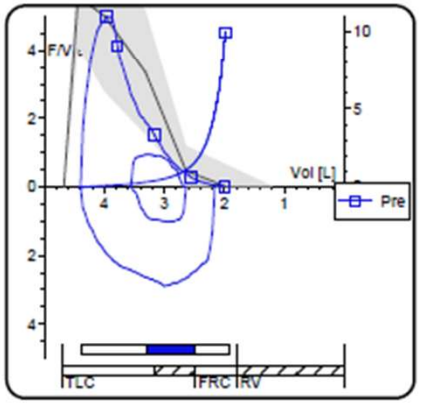


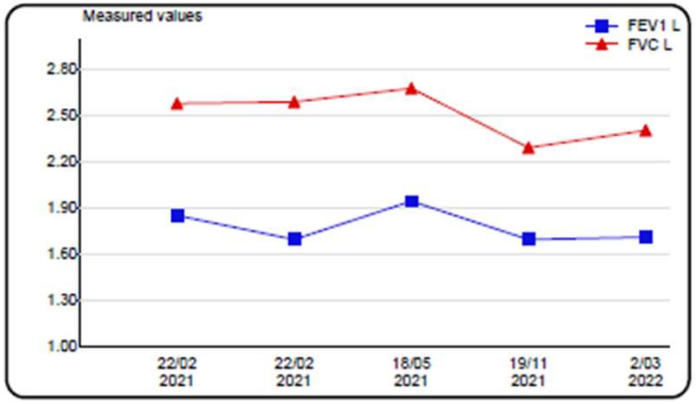
Test performance was sound with repeatable efforts obtained, meets ATS. FVC to plateau. Nil bronchodilators.

	Pressure mmHg	Temperature °C	Humidity %	Altitude m	Visit date	Visit time
Conditions	749	30	39	57	02.03.22	11:45AM

		Pred	LLN	Pre	%Pred
Level date				02.03.22	
Meas time				11:49AM	
Spirometry / Flow Volume					
FEV1	L	2.14	1.57	1.71	79.8
FVC	L	2.74	2.01	2.40	87.5
FEV1%F	%	78.55	65.47	71.14	90.6
MFEF	L/s	1.87	0.88	1.09	58.3
PEF	L/s	5.57	4.09	5.00	89.9
PIF	L/s			2.91	
Slow Vital Capacity					
VC IN	L	2.91	2.27	2.46	84.5
VC MAX	L	2.91	2.27	2.46	84.5
FEV1%M	%	78.55	65.47	69.32	88.3

Test 4
11 months Post Argon
Plasma Coagulation





Test Comments

Reference values from 4th February 2022 are GLI (2012) for spirometry (ages 3-89), ECCS93 (ages 90+). GLI (2020) for Lung Volumes (ages 5-79) and ECCS (ages 80+). GLI (2020) for DLCO (ages 5-84) and ECCS93 (ages 85+). Compare raw data for studies pre and post 4th February 2022. Test performance was good with repeatable efforts obtained, meets ATS. FVC to plateau. Patient stated they do not take bronchodilators.

Interpretation

Spirometry is within normal liits. Normal flow-volume relationships with no features of central airway flow limitation. Spirometry has been stable since February 2021.

(Physician Final: 03.03.2022 01:18PM, Hukins Craig)

Thank you

- Dr Kwun Fong - for his time and assistance with images, interpretation, case information and general feedback.

- Jo Wex – for her assistance with ethics and presentation feedback and review.

Bibliography

Al Qadi, M, Artenstein, A, Braman, S 2013, *'The "forgotten zone": Acquired disorders of the trachea in adults'*, Respiratory Medicine, vol. 107, pp. 1301-1313.

Centres for Disease Control and Prevention 2022, Adult BMI calculator, viewed 3 February 2022, https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/english_bmi_calculator/bmi_calculator.html.

Des Jardins, T 2013, *Cardiopulmonary Anatomy and Physiology*, 6th edn, Delmar Cengage Learning, New York.

Jafar, N, Islam, E, Alalawi, R 2015, *'Shortness of breath caused by a tracheal web'*, The Soutwest Respiratory and Critical Care Chronicals, vol. 3, no. 9, pp. 52-54.

Stoller, J 1992, '*Spirometry: a key diagnostic test in pulmonary medicine'*, Cleveland Clinical Journal of Medicine, vol. 59, no. 1, pp. 75-78.

Yin, Y & Zhang, L 2010, *'Successful diagnosis and treatment of congenital tracheal web using a fiberoptic bronchoscope'*, Paediatric Pulmonology, vol. 45, pp. 945-947.

Zenker, M 2008, *'Argon plasma coagulation'*, GMS Krankenhaushygiene Interdisziplinar, vol. 3, no. 1, pp. 1-5.