Overview

- Rare autosomal recessive disease with skeletal dysplasia and variable renal, hepatic, and eye abnormalities; variable involvement of CNS and GI systems.
- Overlap of findings with Ellis-van Creveld syndrome, short rib polydactyly syndrome, and oral-facial-digital syndromes.
- Poor survival beyond early infancy.
- Narrow, rigid thoracic cage due to short horizontal ribs, short limbs, underdeveloped iliac wings and acetabula and occasional polydactyly.
- Respiratory failure from restrictive thorax and hypoplastic lungs.
- Possible renal, hepatic, and pancreatic dysfunction if pt survives infancy.
- Chronic renal failure can lead to transplantation.
- Hepatic dysfunction can be controlled with ursodeoxycholic acid but those with severe portal Htn require liver transplantation.
- Occasional pulm Htn and cor pulmonale.
- Surgical enlargement of the thorax has been undertaken to increase chest wall compliance.

Etiology

- Autosomal recessive inheritance, variable phenotype
- Postulated involvement of chromosome 15q13 or *IFT80* gene on chromosome 3

Usual Treatment

- VEPTR thoracoplasty and external distraction thoracoplasty have been successful for Jeune syndrome.
- Older children may require surgery related to renal or hepatic failure or treatment of retinal pathology.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Pulm Htn	Syncope	Increased second heart sound	ECG (RVH) ECHO
RESP	Stiff, small rib cage Hypoplastic lungs Ciliary dysfunction	Pneumonia/respiratory failure Assisted ventilation Asynchronous ventilation with agitation/crying	Small chest Horizontal ribs Cyanosis with crying	ABG CXR Oximetry
GI	Hepatic fibrosis/cysts Pancreatic fibrosis/cysts Foregut dysmotility/malrotation	Failure to thrive Metabolic anomalies Nausea, vomiting	Hepatomegaly	Abdominal US Bilirubin/ LFTs
RENAL	Cysts Nephritis	Polyuria, polydipsia		BUN, Cr, lytes, Ca^{2+}/PO_4, abdominal US
CNS	Occasional hydrocephalus Dandy-Walker malformation Retinal degeneration		Increased OFC (head circumference)	
MS	Short limbs and stature Polydactyly of hands and feet			X-ray of thorax, pelvis

Key References: Keppler-Noreuil KM, Adam MP, Welch J, et al.: Clinical insights gained from eight new cases and review of reported cases with Jeune syndrome (asphyxiating thoracic dystrophy), *Am J Med Genet A* 155A(5):1021–1032, 2011; Waldhausen JH, Redding GJ, Song KM. Vertical expandable prosthetic titanium rib for thoracic insufficiency syndrome: A new method to treat an old problem, *J Pediatr Surg* 42:76-80, 2007.

Perioperative Implications

Preoperative Preparation

- Assess ventilation.
- Evaluate for possible pulm Htn.
- Evaluate renal function and consider LFT.
- High index of suspicion for other organ system involvement.

Monitoring

- Consider arterial catheter.
- Consider central venous access.

Airway

- Small larynx requires smaller ETT size.

Induction

- Agitation may make respirations asynchronous (chest and/or abdomen), causing hypoxemia.

Maintenance

- Lung hypoplasia makes barotrauma high risk; maintain low peak airway pressures.

Extubation

- Ensure adequate ventilation before extubation; postop ventilation may be needed for a prolonged period, specifically after thoracoplasty.

Adjuvants

- Renal/hepatic function assessment guides selection of muscle relaxant and fluid management.

Anticipated Problems/Concerns

- Asynchronous ventilation during crying with hypoxia
- Barotrauma during assisted mechanical ventilation
- Renal and/or liver disease and drug metabolism
- Postoperative respiratory failure requiring ventilatory support

Juvenile Gaucher Disease (Type III/Subacute Neuronopathic)

Lance C. Atchley | Lee A. Fleisher

Risk

- Less than 1:100,000
- Autosomal recessive with no sex predominance
- Panethnic but more common in Northern Sweden and Palestinian town of Jenin

Perioperative Risks

- Abnormal platelet functioning and increased risk of bleeding
- Respiratory failure
- Seizure

Worry About

- Intraoperative blood loss and need for transfusion of PRBC, FFP, and platelets
- Perioperative continuation of anticonvulsant therapy and possible need to supplement
- GERD and aspiration
- Potential presence of restrictive or obstructive lung pathology
- Potential presence of pathologic fractures, including vertebrae
- Type IIIc disease: Intracardiac calcifications—mitral valve, aortic valve, ascending aorta, aortic arch, and coronary ostia

Overview

- Variable clinical expression and severity; presents along a continuum.
- Systemic involvement often present in all forms of Gaucher disease, including type III:
  - Splenomegaly, which may lead to anemia, thrombocytopenia, and leukopenia.
  - Platelet dysfunction independent of splenic involvement.
  - Decrease in coagulation factors.
  - Hepatomegaly.
  - Skeletal involvement, including bone marrow infiltration, osteonecrosis/osteoporosis, and pathologic fractures.
- Systemic involvement more common in type III disease:
  - Pulm involvement ,including interstitial lung disease, pulm Htn, or hepatopulmonary syndrome.
  - GERD with chronic aspiration.
- Specific to type III disease:
  - Slowly progressive neurologic symptoms.
  - Supranuclear horizontal gaze palsy is pathognomonic sign.
  - Seizures may be present.
  - Oculomotor apraxia.
  - Three subtypes:
    - Type IIIa: Myoclonus; dementia

- Type IIIb: Early onset of isolated horizontal supranuclear gaze palsy; aggressive systemic illness
- Type IIIc: Intracardiac calcifications—mitral valve, aortic valve, ascending aorta, aortic arch, and coronary ostia

Etiology

- Autosomal recessive deficiency of the lysosomal enzyme acid beta-glucosidase.
- Results in accumulation of glucosylceramide in various tissues, most often lysosomes of macrophages.
  - Can lead to macrophage clumping in liver, spleen, and bone marrow.
  - Hypersplenism may result in anemia, thrombocytopenia, and leukopenia.
  - May also accumulate in lungs, skin, conjunctiva, kidneys, and heart.
- Specific to type III (juvenile Gaucher):
  - Most common mutation is a variant of L444P, but other missense/null mutations may occur.
  - Type IIIa: No specific mutation.
  - Type IIIb: Predominantly homozygous mutation of L444P.
  - Type IIIc: Homozygous mutation of D409H.

Usual Treatment

- ERT

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Corneal opacity Oculomotor apraxia (see CNS) Anorexia	Visual disturbances Nutritional deficiencies Fatigue	Corneal deposits	
RESP	Interstitial lung disease Cor pulmonale Obstructive or restrictive pulmonary disease	Difficulty breathing Fatigue Dyspnea on exertion Chest pain	Rales and/or rhonchi on auscultation Expiratory wheezing Labored breathing	CXR, PFTs, ABG ECHO or right heart cath to evaluate cor pulmonale
CV	Present in type IIIc: Mitral valve calcification Aortic valve calcification Aortic calcifications Coronary ostia calcifications	Easy fatigability Dyspnea on exertion Decreased activity Chest pain	Heart murmur—may be diastolic or systolic	ECHO Chest CT ECG
GI	Splenomegaly Possible splenic infarction or rupture Hepatomegaly Possible liver fibrosis with resultant portal hypertension and liver failure	Usually painless splenomegaly but could present as painful if splenic infarction or rupture occurs Postprandial gastric fullness possible	Hepatosplenomegaly on palpation	AST, ALT, alk phos, albumin, total protein, bilirubin, calcium, phosphorus Abdominal US Abdominal CT
RENAL	Variable proteinuria Possible renal insufficiency			Urinalysis BUN/Cr
CNS	Horizontal supranuclear gaze palsy Convulsive crises Ataxia Oculomotor apraxia Seizures Dementia Myoclonus	History of the occurrence of any of the aforementioned effects	Careful eye examination for oculomotor apraxia or gaze palsy	CT scan of head
HEME	Thrombocytopenia (most common) Platelet dysfunction Anemia Leucopenia Coagulation factor deficiency	Abnormal bleeding Easy bruising	Petechiae Ecchymosis	CBC, differential PT/ INR, PTT Platelet function assay Clotting time Iron, ferritin, transferrin Vitamin B_{12}
MS	Osteopenia Osteoporosis Bone marrow infiltration Pathologic fractures Avascular necrosis	Chronic pain Easy fracturing "Bone crises"	Bony deformity Painful palpation Painful ROM Restricted ROM Short stature possible	X-ray DEXA Bone marrow biopsy MRI CT scan

Key References: Tobias JD, Atwood R, Lowe S, et al.: Anesthetic considerations in the child with Gaucher disease, *J Clin Anesth* 5(2):150–153, 1993; Martins AM, Valadares ER, Porta G, et al.: Recommendations on diagnosis, treatment, and monitoring for Gaucher disease, *J Pediatr* 155(Suppl, 4):S10–S18, 2009.

Perioperative Implications

Preoperative Preparation

- Assessment of platelet function, platelet count, hemoglobin, and coagulation factors.
- Preparation for potential transfusion needs, including PRBC, FFP, and platelets.
- Measurement of serum anticonvulsant levels to ensure that these levels are within therapeutic range.
- Liver function testing.
- ECG and consider ECHO, especially if concern for type IIIc disease.
- Consider ranitidine and metoclopramide preop given increased risk of GERD.
- Consider CXR and ABG and PFTs in pts with pulm involvement.
- Consider antisialagogue for pts with copious oral secretions.
- Enzyme replacement therapy in the preoperative period has shown to decrease organomegaly and improve hematologic abnormalities in adult disease and may also be of benefit in juvenile disease.

Monitoring

- Standard ASA monitoring with consideration for more invasive monitoring depending on procedure, with specific attention to risk of blood loss

Airway

- Pts may present with restrictive or obstructive airway disease.
- Copious secretions may be present.
- Airway obstruction could occur with induction if pt has bulbar involvement with resultant poor control of pharyngeal musculature and/or infiltration of upper airway with glycolipids.
- Pathologic vertebral fractures should be of consideration for potential cervical instability.
- Few reports of airway management difficulties; however, thorough preoperative evaluation with consideration for possible difficulties should be performed.

Induction

- Consider rapid sequence induction with cricoid pressure in pts with significant GERD.
- Special care when positioning due to increased risk of pathologic fracturing.
- Special care with padding bony prominences due to increased risk of pressure necrosis in pts with severe CNS involvement and malnutrition.

Maintenance

- No specific advance of one technique over the other
- Choice of muscle relaxant more controversial given CNS involvement, but no reported adverse effects with use of succinylcholine

Extubation

- Ensure airway protective reflexes are intact prior to extubation due to increased risk of GERD and aspiration

Adjuvants
- Careful consideration to increased bleeding risk if considering regional anesthesia.
- Must obtain bleeding time, coagulation studies, and platelet count prior to performing regional anesthesia.
- Parenteral opioids are acceptable.

Postoperative Period
- Extended postoperative monitoring for 24 h with pulse oximetry
- May require frequent suctioning and positioning especially with more severe CNS dysfunction
- Continue anticonvulsive therapy
- May require PRBC and/or FFP transfusion for continued bleeding

Anticipated Problems/Concerns
- Intraoperative hemorrhage with the potential for continued hemorrhage in the postop period
- Respiratory failure and pulmonary complications in pts with lung involvement
- Aspiration
- Seizures

Kartagener Syndrome

Nancy C. Wilkes

Risk
- KS, first described in 1933, is part of a larger family of diseases classified as PCD.
- The triad of KS consists of bronchiectasis, chronic sinusitis, and situs inversus; it has an incidence estimated at 1:15,000–40,000 births.
- The disease is likely underdiagnosed because a limited amount of centers have resources to provide an accurate diagnosis.
- No known predilection for race or gender.
- Symptoms more prevalent in children in the first decade of life.

Perioperative Risks
- Morbidity: Lung infection, pulm edema, atelectasis, sinusitis

Worry About
- Pulm function and anatomy.
- Airway obstruction due to ineffective clearance of secretions.
- Bronchiectasis, which can lead to cor pulmonale, amyloidosis, and pulm edema and is usually found in the middle or lower lobes in KS pts, as opposed to the upper lobes in cystic fibrosis pts.
- Chronic disease with variable onset.
- Chemical injury from aspiration in left lung, which is the larger lung in pts with KS.
- Unintended bronchial intubation with single-lumen ETT, resulting in nonventilation of right lung (in those with pulm inversion).
- Left-sided double-lumen tubes may occlude orifice of left upper lobe.
- Nasal catheters relatively contraindicated because of risk of paranasal sinusitis and ear infections.
- Increased susceptibility to overall infection due to impaired neutrophil chemotaxis.

Overview
- Complete situs inversus (including dextrocardia).
- PCD resulting in chronic respiratory tract infections, bronchiectasis, and sinusitis.
- Approximately half of patients with PCD have situs inversus and thus are classified as having KS.

Etiology
- Congenital defect in synthesis of various parts of cilia (dynein arms, radial spokes, nexin links, microtubules) that results in abnormal/dyskinetic ciliary movement.
- Ciliated epithelium covers most areas of the upper resp tract, including the nasal mucosa, paranasal sinuses, middle ear, eustachian tube, and pharynx. The lower resp tract contains ciliated epithelium from the trachea to the resp bronchioles.
- Autosomal recessive inheritance pattern; genetically heterogeneous with multiple chromosomes likely responsible for phenotype.

Usual Treatment
- Aerosol administration to reduce secretion viscosity
- Antimicrobial therapy for chronic resp tract infections and sinusitis
- Surgical intervention for persistent bronchiectasis
- Conventional and assisted airway clearance techniques (chest physiotherapy, PEP mask, forced oscillation techniques, exercise programs, and physical activity)
- Nasal steroid sprays
- Inhaled bronchodilators and anti-inflammatory medications to treat bronchospasm

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Dextrocardia		Right-sided heart tones	CXR, ECHO, ECG
RESP	Bronchiectasis Ciliary dyskinesia	Dyspnea Cough Halitosis	Decreased breath sounds, rhonchi, crackles, wheezes	CXR, bronchoscopy, spirometry, bronchography
IMMUNO	Chronic pansinusitis, nasal polyposis Bronchitis	Nasal drainage, morning sore throat Cough, mucus production	Frontal and maxillary tenderness Rhonchi	CT sinuses Sputum and tracheal aspirate for culture and Gram stain
	Pneumonia Otitis media	Cough, fever Earache, hearing loss	Rales, rhonchi Erythematous tympanic membrane	CXR, SpO_2 Audiometry, tympanotomy

Key References: Leigh MW, Pittman JE, Carson JL, et al.: Clinical and genetic aspects of primary ciliary dyskinesia/Kartagener syndrome, *Genet Med* 11(7):473–487, 2009; Mathew PJ, Sadera GS, Sharafuddin S, et al.: Anaesthetic considerations in Kartagener's syndrome–a case report, *Acta Anaesthesiol Scand* 48(4):518–520, 2004.

Perioperative Implications

Preinduction
- Consider omitting anticholinergics and cough suppressants from preanesthetic medication.
- Chest physiotherapy, bronchodilators, and incentive spirometry are often beneficial.
- Treat underlying pulm infections.
- Immunize against influenza A and pneumococcal organisms.

Monitoring
- In dextrocardia, position of ECG leads should be the mirror image of normal, as should that of paddles of external defibrillation, cardioversion, and pacing.
- Because the great vessels and thoracic duct are likely to be reversed, consider cannulation of the internal jugular vein from the left.
- Pulm artery cath should be oriented in anticipation of a clockwise direction of migration.
- Pregnant pts with KS should be positioned in right uterine displacement rather than left.

Induction and General Anesthesia
- Emphasize aseptic technique secondary to abnormal neutrophil chemotaxis.
- Aim for nontraumatic airway manipulation to avoid possible infection.
- Humidify inspired gases.
- Inhalation injury usually occurs in left lung, which is also larger lung.
- Bronchial intubation with a single-lumen ETT usually involves left side.
- Right bronchial suctioning will be more difficult to perform with nonangulated suction cath.
- Left-sided double-lumen tubes may occlude orifice of left upper lobe.
- When lung isolation is needed, consider tracheal intubation first with a bronchial blocker in the appropriate bronchus.
- If a double-lumen tube is required, consider inserting a left-sided tube with the bronchial tube on the right; the endobronchial stylet and the upper part of tube must be bent 180 degrees from original orientation prior to insertion such that the normal curvature of the oropharynx is still followed. The same principles apply to use of a right-sided tube.
- Extubation of the trachea should occur as soon as possible after the patient meets common extubation criteria.