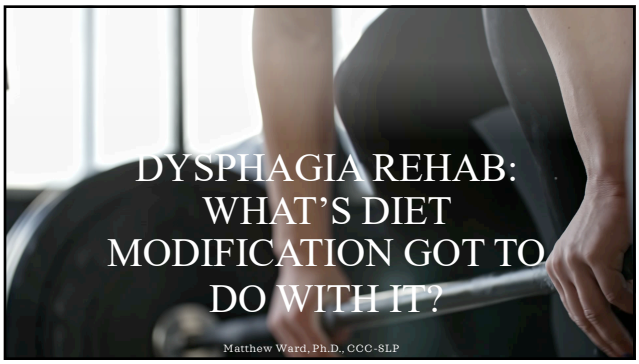


1

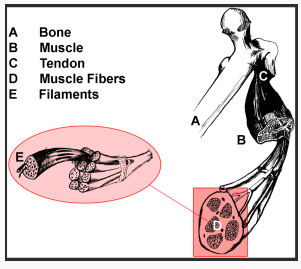
What's Our Goal?

"The goal of swallowing is to complete this process [rapid, precise, coordination of more than 25 muscle pairs and 5 cranial nerves] safely and efficiently to maintain nutrition, hydration, and quality of life."

(Vose & Humbert, 2018)

2

Swallowing: A Neuromuscular Process



(Ziereth & Hawley, 2004)

3

Muscle Fiber Type and Function

- Type I – "slow twitch"
  - Built for endurance and resist fatigue
- Type II – "fast twitch"
  - Built for high velocity/high amplitude and fatigue quickly

4

Oropharyngeal Muscle Fiber Type

- Oropharyngeal muscles represent a unique mix of type I and II fibers.
- They are robust, and they are often resistant to disease processes that result in weakness and loss of function that is seen often in the skeletal muscle of the limbs.

Quick fact: disuse atrophy causes loss of type I fibers first, but sarcopenia results in loss of type II muscle fibers first.

(Mohammed et al., 2021)

5

Aging, How It Changes Things

- Normal aging
  - A general loss of muscle fibers reducing strength & timing- or loss of strength reserve
  - In healthy aging individuals, swallowing is not naturally compromised
- If there is no apparent causative disorder for dysphagia, the cause *may be sarcopenia* (Wakabayashi, 2015).
- Primary Sarcopenia by aging: a progressive decrease of skeletal muscle mass & power (Maeda & Akagi, 2015).

6

Effects of Aging

- Tongue
  - Maximum tongue strength & peak tongue pressure decrease
- Hyoid
  - Displacement (magnitude & velocity) remain about the same
- Larynx
  - Anterior elevation reduced; may be lower in neck

7

Effects of Aging

- Pharynx
  - Reduced constricting force; larger lumen due to muscle loss; slower bolus transit
- UES
  - Relaxation & opening timing delay; reduced resting pressure

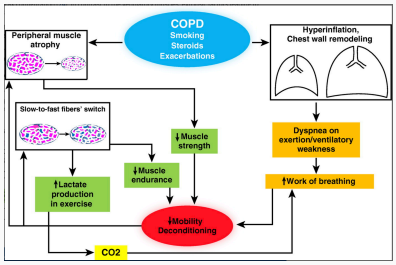
8

Effects of Disease on Muscles

- Paneroni et al., 2021
  - Significant loss in strength & endurance for patients hospitalized with COVID-19
  - Mild-moderate exertion after ADLs

9

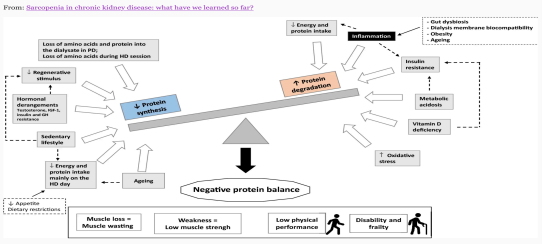
COPD and Muscle Dysfunction



(Jaitovich & Barreiro, 2018)

10

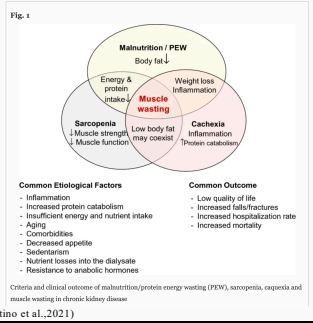
Chronic Kidney Disease and Muscle Loss



(Sabatino et al.,2021)

11

CKD Muscle Loss: Etiologies



(Sabatino et al.,2021)

12

Example: Pharyngeal Constrictors

- Upper airway muscles are distinct from skeletal limb muscles with differing:
  - Embryologic origins
  - Sources of innervation
  - Anatomic function

(Mu & Sanders, 2007)

13

Pharyngeal Constrictors: Two Life-Sustaining Anatomic Functions

- Breathing (postural):
  - Rigidity of PCs allows airway patency with inhalation/exhalation.
  - Also provides the structure to make speech sounds.
- Swallowing (ballistic):
  - Delivers food and liquid to the digestive system to distribute water and nutrients to cells throughout the body.

(Mu & Sanders, 2007)

14

Specialization of Pharyngeal Constrictors

- Breathing (postural):
  - Predominantly **type I** muscle fibers
  - Slow inner layer (SIL) of the muscle
  - Innervation = CNIX
- Swallowing (ballistic):
  - Predominantly **type II** muscle fibers
  - Fast outer layer (FOL) of the muscle
  - Innervation = CNX

(Mu & Sanders, 2007)

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Pharyngeal Constrictor Muscles: Fiber Type & Innervation

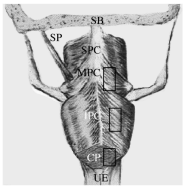
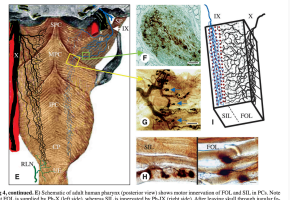


Fig 1. Schematic of human pharynx (posterior view) illustrates arrangement of pharyngeal constrictor (PC), cricopharyngeus (CP), and stylopharyngeus (SP) muscles and tissue sampling sites (enclosed regions) for immunocytochemistry. IPC — inferior PC; MPC — middle PC; SB — skull base; SPC — superior PC; UE — upper esophagus.



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Pharyngeal Constrictors: Development of a Two Layered Structure

- The dual layer structure (fast inner layer and slow outer layer) of PC's is not seen at birth but is well developed by age 2.
- The makeup of the dual layered PC's changes with ageing and with disease

(Mu & Sanders, 2007)

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Pharyngeal Constrictors: Ageing & Parkinson's Disease

	Dual Layer (SIL & FOL)	Percentage of Type I Fibers in FOL
Newborn	Not developed	n/a
2 Year old	Fully developed	n/a
56 years	Fully developed	32%
71 years	FOL in decline	73%
Parkinson's disease (adult)	FOL in decline	81%

(Mu & Sanders, 2007)

18

Exercise Physiology for the Win!

- Normal physiological patterns require:
  - An intact neurological system and
  - The strength and endurance of the oropharyngeal muscles

19

Dysphagia: What Can We Do?

Rehabilitation Requires

- *Strength
- Skill training

"The goal of swallowing is to complete this process [rapid, precise, coordination of more than 25 muscle pairs and 5 cranial nerves] safely and efficiently to maintain nutrition, hydration, and quality of life."

20

Overall Strength

- Impacts
  - Force generation
  - Amplitude of movement
  - Endurance of muscle contraction
  - Timing
  - Coordination

21

Skill Training

- Impacts
  - Coordination
  - Precision
  - Accuracy
  - Repeatability
  - Efficiency of eating & drinking

22

Exercise Physiology: Basic Principles

- Overload Principle
  - Muscle cannot be trained without demanding more from it than it is used to giving
  - With improvement, the overload will need to be increased (progressive overload)

(Saxon & Schneider, 1995)

23

Overloading Oropharyngeal Muscles

- Can be achieved via
  - Increasing the resistance against muscle contraction (*strength training*)
  - Increasing the amount of repetitions of muscle contraction (*endurance training*)

24

Resistance Training

- Electrical stimulation that causes depression of the hyolaryngeal complex can add resistance to oropharyngeal muscles.
- Increasing bolus volume/consistency can add resistance
- sEMG allows for the determination of 1 repetition max and setting targets for exercises such as the effortful swallow
- To overload muscles, resistance must be >40% greater than a one repetition max

25

Exercise Physiology: Basic Principles

- Specificity Principle
  - Skill improvement must focus on the muscle groups & movement patterns (neuromuscular) involved in the desired activity.
  - Aberrant motor patterns result in maladaptive motor patterns that inhibit rehabilitation

(Saxon & Schneider, 1995)

26

Skill Training

- The sequence of muscle contractions for swallowing are rapid, precise, and coordinated.
- Strengthening alone will not improve function.
- Muscles of swallowing move in multiple planes, and training requires accurate form

27

Exercise Physiology: Basic Principles

- Individuality Principle
  - Training must address the individual needs & capacity of person undergoing treatment
    - A standard exercise regimen cannot be used with every patient.
    - Dosage (number of sets, repetition, and sessions) may need to be adjusted for individual patients

(Saxon & Schneider, 1995)

28

Individuality and Neurogenic Disease

- Adverse effects of exercise have been reported in patients with neurogenic disease (e.g., Parkinson's disease, ALS, MS, etc.)
- However, current literature suggests that moderate levels of exercise can increase strength without deleterious effects.

(Lui & Byl, 2009)

29

Exercise Physiology: Basic Principles

- Reversibility Principle
  - When exercise schedules are stopped or missed, "detraining" occurs; loss of gained strength or skill
  - Unweighting a muscle can result in atrophy within 4 hours
  - True hypertrophy of muscle requires 4-6 weeks of training.
    - Early gains in strength often result from recruiting more motor units and from neural reorganization

(Saxon & Schneider, 1995)

30

A Word about Nutrition

- Severe disease is characterized by a loss of total body protein mass (Genton & Pichard, 2013).
- Without adequate nutrition and hydration, strength cannot be built.

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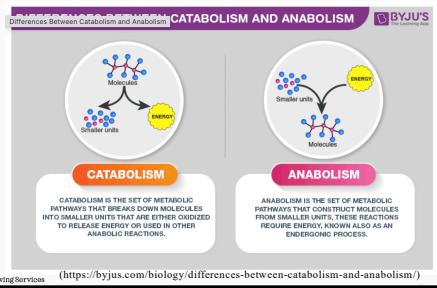
Catabolism & Anabolism



 (https://byjus.com/biology/differences-between-catabolism-and-anabolism/)

32

Catabolism & Anabolism

Difference Between Catabolism and Anabolism	
Catabolism	**Anabolism**
Catabolism breaks down big complex molecules into smaller, easier to absorb molecules.	Anabolism builds molecules required for the body's functionality.
The process of catabolism releases energy.	Anabolic processes require energy.
Hormones involved in the processes are adrenaline, cytokine, glucagon, and cortisol.	Hormones involved in the process are estrogen, testosterone, growth hormones and insulin.
Examples of catabolic processes are proteins becoming amino acids, glycogen breaking down into glucose and triglycerides breaking up into fatty acids.	Examples include the formation of polypeptides from amino acids, glucose forming glycogen and fatty acids forming triglycerides.
In catabolism, potential energy is changed into kinetic energy.	In anabolism, kinetic energy is converted into potential energy.
It is required to perform different activities in living entities.	It is required for maintenance, growth, and storage.

 (https://byjus.com/biology/differences-between-catabolism-and-anabolism/)

33

Management of Nutritional Intake

- Diet texture modification = most common intervention by SLPs

34

Modified diets

"Modified diets are a more intrusive intervention than any medication and are widely used in the absence of a high-quality evidence base."

(O'Keeffe, 2018)

35

Patient autonomy

- How often do we discuss the known risks of altered diets with our patients?
- How many of the risks associated with modified diets and thickened liquids do we actually know?

36

SLP Understanding of Modified Diet Textures & Thickened Liquids

- Survey of SLP understanding of possible side effects of modified texture diets (TMD) and thickened liquids (TL)
  - 13 known complications of consuming TMD & TL
- Of the 253 SLPs surveyed the average score (out of a possible 13) was 6.72

(Unpublished Poster: Ward & Bowman, 2022)

37

Experience & Training

- SLPs were no more likely to correctly identify the known risks of TMD & TL when controlling for:
  - Age
  - Years of experience
  - Years of experience evaluating dysphagia
  - Specialty training (MDTP, LSVT, CCC, MBSImP)
  - Level of education (PhD, M.A., M.S., clinical doctorate, etc.)
  - Board Certification in Swallowing & Swallowing Disorders
  - Primary work setting (SNF, acute, outpatient, LTACH, etc.)

(Unpublished Poster: Ward & Bowman, 2022)

38

Known complications with modified diets

- Malnutrition
  - Dehydration, poor recovery from illness, debilitation, prone to infections
- Dehydration
  - Renal failure, constipation, UTI, impaired mental status, respiratory infection, hypotension, delirium, poor recovery from illness, fever
- Significantly reduced quality of life
  - Patient descriptions: "vile" & "awful"
- Slowed digestion/delayed gastric emptying
- Interfere with medication absorption
- Increase economic cost

(Begum, 2010; Cichero, 2013; Mukand, 2003; Nadel, 1980; O'Keeffe, 2018; Swann et al., 2015; Wotton, 2008)

39

Modified diets and Pneumonia

- Thickened liquids are ordered for up to ¼ of all long-term care residents (Castellanos et al., 2004).
- 30-45% of residents in rehabilitation facilities receive modified diet textures (Keller et al. 2012).

40

Evidence-based practice

- "There is ***no convincing evidence*** to suggest that texture modified foods and thickened liquids benefit adults with dysphagia by preventing pneumonia and its consequences" (O'Keeffe, 2018).

(Abdelhamid et al., 2016; Alagiakrishnan et al., 2013; Anderson et al., 2013; Beck et al., 2017; Bilney et al., 2003; Campbell-Taylor, 2008; Foley et al., 2008; Greeganage et al., 2012; Hanson et al., 2011; Hines et al., 2010; Jones et al., 2016; Knuijt et al., 2011; Loeb et al., 2003; Painter et al., 2017; Sakashita et al., 2014; Speyer et al., 2010; Steele et al., 2015; Thomas, 2008; Vogel et al., 2015)

41

Evidence-based practice

- Long-term prospective and retrospective studies of altered diet recommendations, based on instrumental observation of laryngeal penetration/aspiration, have NOT found a significant correlation between aspiration and pulmonary complications or survival.

(Bock et al., 2017; Feinberg et al., 1996)

42

"non-compliance"

- With regard to medical decision-making, ***quality of life*** is ***as important or more important*** to individuals than quantity of life (Case et al., 2015; Fahey et al., 2017; Janssens et al., 2018; May et al., 2009; Meropol, 2008).
- "***Non-compliance***" with recommendations for altered diets—due to reduced quality of life—***is both rational and understandable*** (Lim et al., 2016; Swann et al., 2015).

43

Patient determination

- It is ***for the patient to decide*** the balance of risk of aspiration and possible pulmonary complications vs. the reduced quality of life and risks associated with altering diet textures.
- "It would be ***unacceptable*** to seek to withhold information about the possible hazards of modified fluids to try and improve adherence to clinician recommendations."

(O'Keeffe, 2018)

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