

Relevance and effect of tongue strengthening exercises

Gwen Van Nuffelen, Leen Van den Steen, Cindy Guns, Els Verhaeghe, Anke Aerts, Olivier

Vanderveken, Diane Van Rompaey, Marc De Bodt

Jan Vanderwegen, Johan Allouche - CHU Saint-Pierre

Kennis / Ervaring / Zorg



Intensive tongue strengthening exercises

- Function and importance of tongue strength
- Intensive TSE: what?
- TSE and the other main principles of strength training (specificity & transference)
- Effect of TSE
- How to do it?

Importance of TS

Kennis / Ervaring / Zorg



Importance of TS

Bolus containment

TS is considered to be the main driving force for bolus propulsion

Transfer food and liquids from mouth to throat and oesophagus



Steele 2012; Sura et al. 2012
Ono T et al 2007, Butler SG et al 2011,

Importance of TS

Insufficient TS pressures are related to

- pharyngeal (vallecular) residue
- high risk for (silent) aspiration
- aspiration pneumonia
- endangers adequate oral nutrition (insufficient intake, prolonged meal duration)

Lazarus 2009, 2007, 2000, Rademaker et al, 1994*,
Ku et al. 2007, Smith et al. 2000, Pauloski et al 2009, Molfenter, 2013

Intensive TSE: what are we talking about?

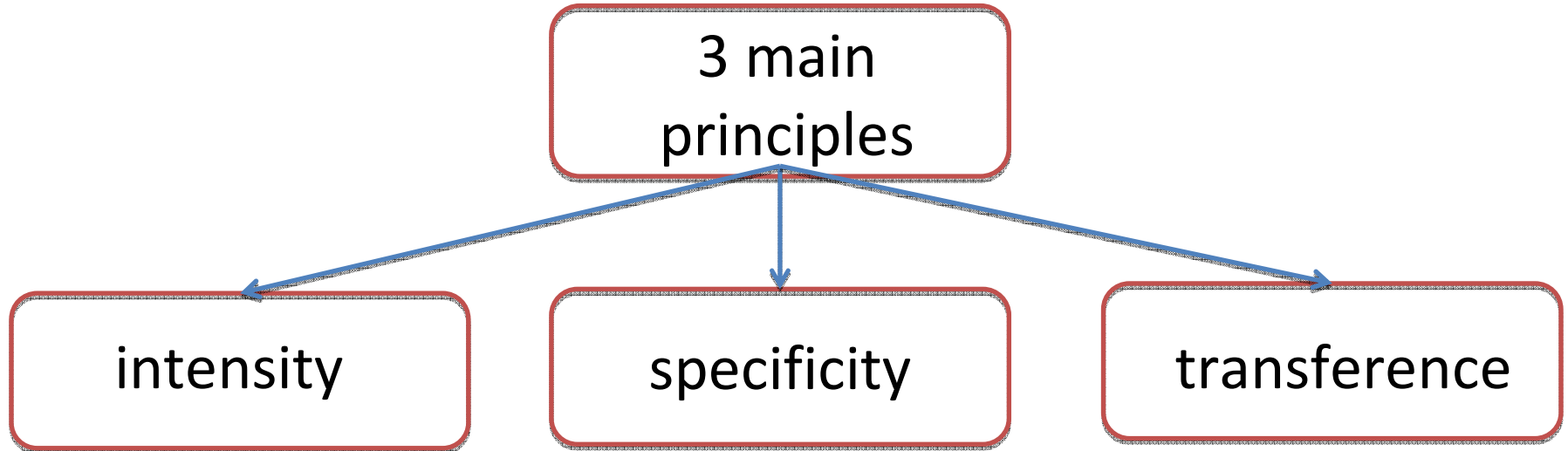
Kennis / Ervaring / Zorg



Tongue strengthening exercises

- (Partially) based upon principles of exercise / strength training
- Current knowledge on how to obtain maximum benefit is derived from physical rehabilitation, exercise science and sports training

Principles of strength training



Principles of strength training

Tendency to

- implement these principles of exercise in swallowing rehabilitation methods

- find out to which degree current methods meet these principles

- McNeill Dysphagia Therapy Program

- Expiratory / inspiratory Muscle Strength Training

- Tongue Strength Exercises

-

Principles of strength training

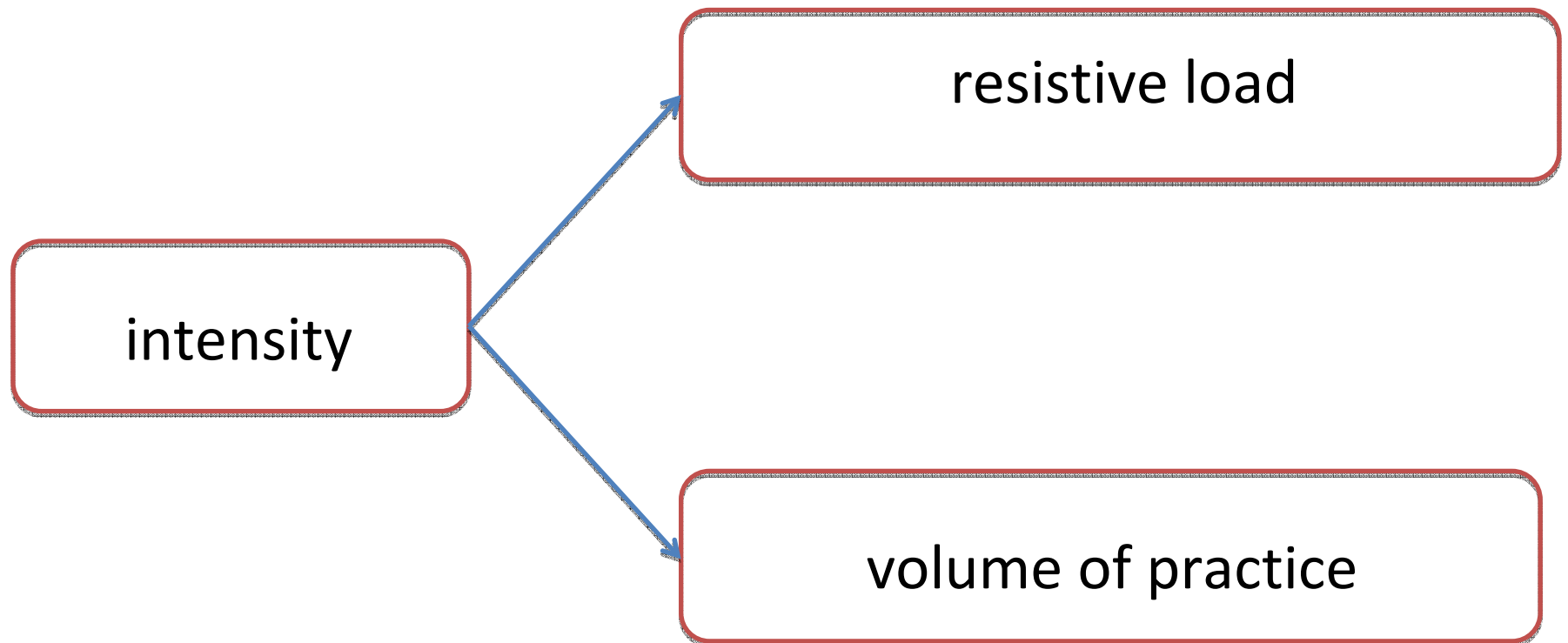
Strength-Training Exercise in Dysphagia Rehabilitation: Principles, Procedures, and Directions for Future Research

Lori M. Burkhead, PhD,^{1,3} Christine M. Sapienza, PhD,^{2,3} and John C. Rosenbek, PhD^{1,3}

Dysphagia 22:251–265 (2007)
DOI: 10.1007/s00455-006-9074-z

Dysphagia
© Springer Science+Business Media, LLC 2007

Principles of strength training

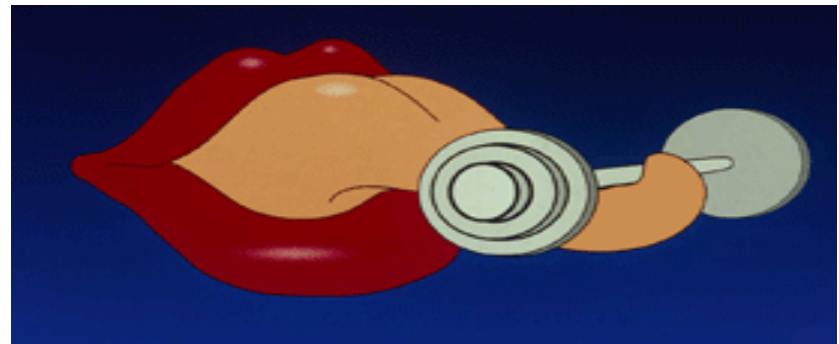


Resistive loading

Principle of overload

-exercises that do not force the neuromuscular system beyond the level of usual activity will not elicit adaptations

-Progressive resistance:
increase force-generating
capacity → increase load



Resistive loading

progressive resistance: rules based on large muscle groups

- load is a proportion of maximal force-generating capacity

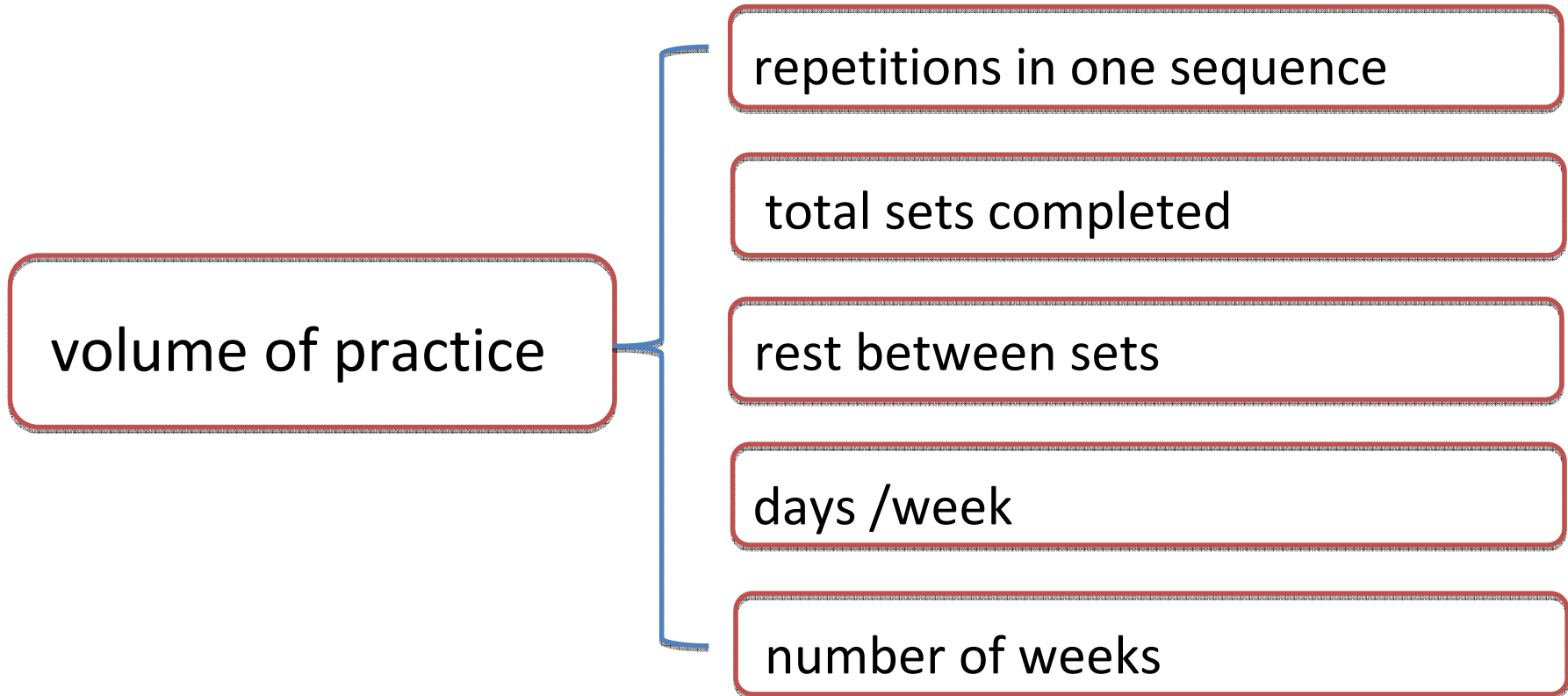
- i.e. a percentage of the 1-Repetition Maximum (1RM)

- starting point: 60%

- higher starting level → better/ faster outcome?

- needs investigation but some suggest that this may lead to overuse injuries

Volume of practice



Volume of practice

- Currently no knowledge on the 'ideal' volume of practice for oropharyngeal muscles
- No dose-dependent studies
- But: outcome studies indicate strength training requires:
 - multiple repetitions/session
 - multiple days/week
 - multiple weeks

Study	Weeks	Sessions	Duration/trials
Lazarus et al. 2003	4		
Clark et al. 2009	9		
Robbins et al. 2005	8	3x/week	3x 30 trials/day
Robbins et al. 2007	8	3x/week	3x 30 trials/day
Yeates et al. 2008		2-3x/week	40 minutes
Steele et al. 2013		24	60 trials
Van Nuffelen et al. 2012 DRS	4	5x/week	15 Ant -15 Post MIP 12 Ant – 12 Post Endurance
Van Nuffelen et al. 2013 DRS	4 - 8	3-5x/week	15 Ant -15 Post MIP 12 Ant – 12 Post Endurance

Specificity and transference

Kennis / Ervaring / Zorg



Specificity

If you want to become a good swimmer, swim

If you want to become a good runner, run

If you want to be become good in swallowing, swallow

- Simply improving endurance or strength of a specific muscle group, is not necessarily enough for improved performance of a specific task
- McNeill Dysphagia Therapy Program (Crary & Mann)
- Tongue strengthening exercises?

Transference

BUT! we also know from physical rehabilitation that

- isolated strength-training regimes that incorporate progressive resistance have been shown to transfer to improved performance in functional activities
- in conjunction with or as precursor
- in frail or decompensated individuals with significant weakness

→ Can explain how exercises that are not swallowing-specific may improve swallowing function

E.g. tongue strengthening exercises, EMST, LSVT, ...

Specificity & transference: tongue muscles

'tongue muscle' differs from most other skeletal muscles
(muscle hydrostat)

- composed almost entirely of muscle
- any one movement goal may be accomplished by a variety of muscle activation patterns
- any muscle fiber may be recruited for a number of movement goals

→ specificity?

Specificity & transference: tongue muscles

Study	Specificity	Results
Lazarus et al. 2003	Yes	high resistance TSE <ul style="list-style-type: none">• increased tongue strength• no impact on endurance
Clark et al. 2009	No	direction of TSE (protrusion, elevation, lateralization) <ul style="list-style-type: none">• exercises for a specific direction result also in an improvement of strength in the other directions• no significant differences between methods!
Clark 2012	(Yes)	exercises for strength, endurance, power <ul style="list-style-type: none">• significant differences in effect size

Specificity & transference:tongue muscles

And remember:

Indications that TSE can improve *functional swallowing*

-improvement of PAS (Robbins et al. 2005/2007; Steele et al. 2013)

-reduction of pharyngeal residue (Robbins et al. 2005/2007)

- however: Steele et al. 2013: no improvement, even worsening

Effect of Tongue Strengthening Exercises

Kennis / Ervaring / Zorg



Effect of TSE

Accumulating evidence that TSE can improve *Maximal Isometric Tongue Pressures (MIP)* in different populations

Study	Participants	N
Lazarus et al. 2003	Healthy adults	31
Clark et al. 2009	Healthy adults	39
Robbins et al. 2005	Healthy elderly	10
Robbins et al. 2007	Stroke	10
Yeates et al. 2008	Stroke & brain injury	3
Steele et al. 2013	Brain injury	6
Van Nuffelen et al. 2012	HNC – CRT	6
Van Nuffelen et al. 2013	Neurodegenerative diseases	9

Effect of TSE

Indications that TSE can improve *functional swallowing*

-improvement of PAS (Robbins et al. 2005/2007; Steele et al. 2013)

-reduction of pharyngeal residue (Robbins et al. 2005/2007)

- however: Steele et al. 2013: no improvement, even worsening

Tongue Strengthening Exercises

Indications that TSE can

- change muscle structure and contraction capacity
- increase tongue volume
- result in cortical plasticity
- Swal-QoL

Robbins et al. 2005/2007, Steele et al. 2013, Svensson et al. 2006, Anima et al. 2011,
Kletzien et al. 2012, Connor et al. 2009

Which patient could benefit from
TSE?

Kennis / Ervaring / Zorg

UZA'

Pathophysiology

Main indication: residue base of tongue & valleculae

Other possible indications (compensation):

- hypopharyngeal residue
- reduced opening of the UES
- elongated oropharyngeal transport

Pathology



Study	Participants	N
Lazarus et al. 2003	Healthy adults	31
Clark et al. 2009	Healthy adults	39
Robbins et al. 2005	Healthy elderly	10
Robbins et al. 2007	Stroke	10
Yeates et al. 2008	Stroke & brain injury	3
Steele et al. 2013	Brain injury	6
Van Nuffelen et al. 2012	HNC – CRT	6
Van Nuffelen et al. 2013	Neurodegenerative diseases	9

Normative data

Dysphagia

DOI 10.1007/s00455-012-9425-x

ORIGINAL ARTICLE

The Influence of Age, Sex, Bulb Position, Visual Feedback, and the Order of Testing on Maximum Anterior and Posterior Tongue Strength and Endurance in Healthy Belgian Adults

**Jan Vanderwegen · Cindy Guns · Gwen Van Nuffelen ·
Rik Elen · Marc De Bodt**

Q	parameter	answer	implications
1	age*gender	no	separate study is possible
2	age	yes	older = weaker and shorter
3	gender	yes	males = stronger and longer
4	bulb position	yes	anterior tongue = stronger and longer
5	visual feedback	yes	with feedback = stronger

How to do 'modern' TSE?

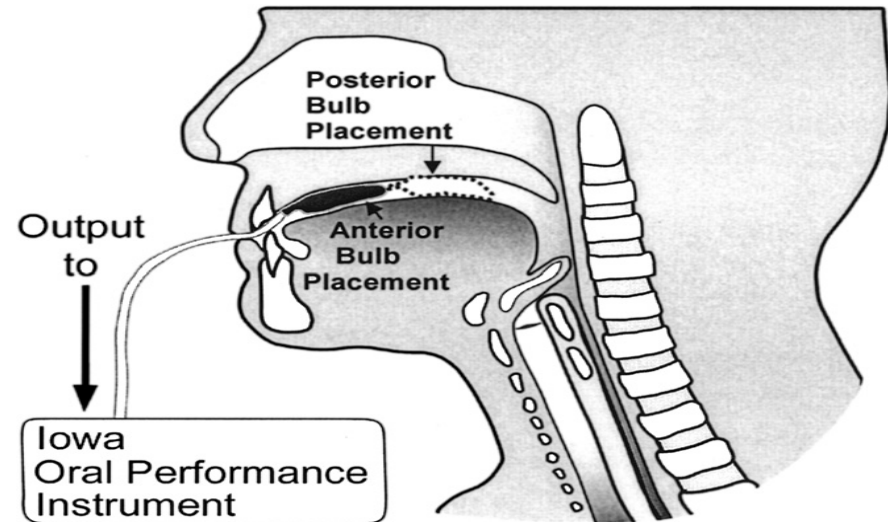
Kennis / Ervaring / Zorg



Iowa Oral Performance Instrument



Study	Participants	N	Method
Lazarus et al. 2003	Healthy adults	31	IOPI – tongue depressor
Clark et al. 2009	Healthy adults	39	tongue depressor
Robbins et al. 2005	Healthy elderly	10	IOPI
Robbins et al. 2007	Stroke	10	IOPI
Yeates et al. 2008	Stroke & brain injury	3	IOPI
Steele et al. 2013	Brain injury	6	IOPI
Van Nuffelen et al. 2012	HNC – CRT	6	IOPI
Van Nuffelen et al. 2013	Neurodegenerative diseases	9	IOPI





=



?

Study	Participants	N	Method
Lazarus et al. 2003	Healthy adults	31	IOPI – tongue depressor
Clark et al. 2009	Healthy adults	39	tongue depressor
Robbins et al. 2005	Healthy elderly	10	IOPI
Robbins et al. 2007	Stroke	10	IOPI
Yeates et al. 2008	Stroke & brain injury	3	IOPI
Steele et al. 2013	Brain injury	6	IOPI
Van Nuffelen et al. 2012	HNC – CRT	6	IOPI
Van Nuffelen et al. 2013	Neurodegenerative diseases	9	IOPI

IOPI

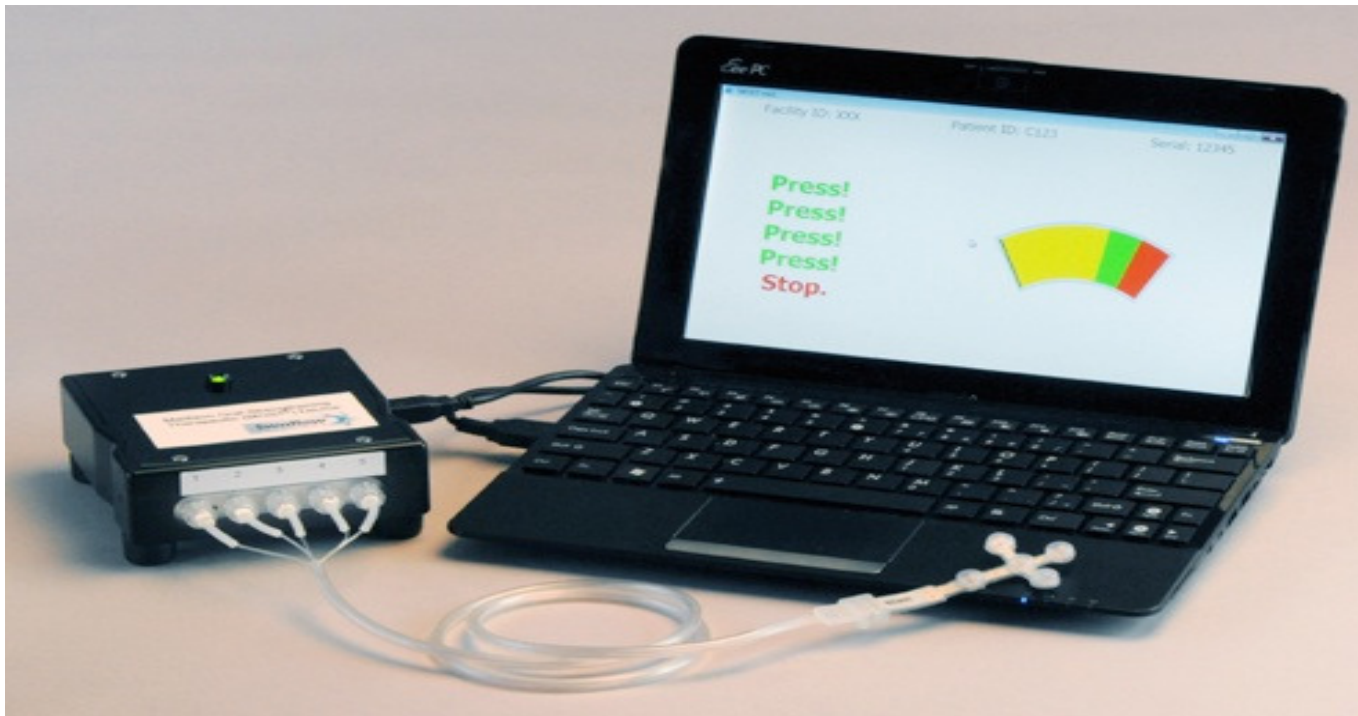
IOPI allows for:

- determination of 1 RM
- practicing at a given % of the patient's 1 RM
- more professional

! tongue depressor not suitable to judge TS (Clark 2003)



MADISON ORAL STRENGTHENING THERAPEUTIC (MOST®) DEVICE (Robbins et al)



Kay Pentax Digital Swallowing Station



Looking at different exercise schemes

Kennis / Ervaring / Zorg



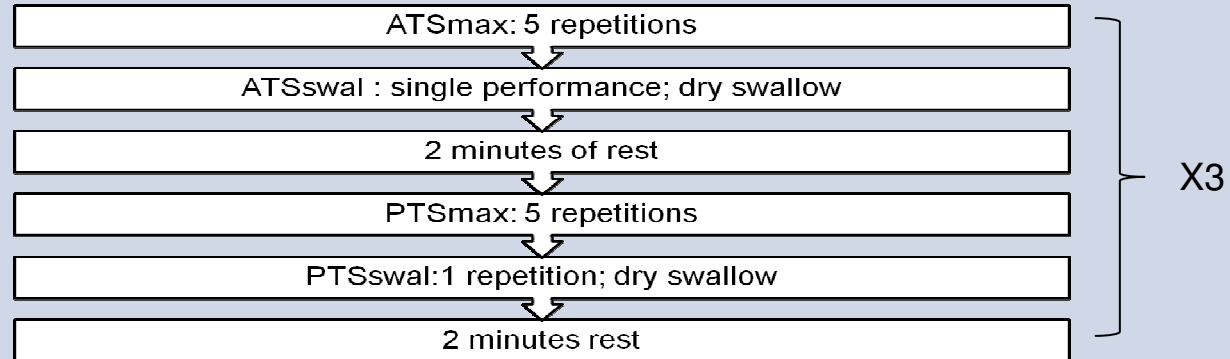
Robbins et al. 2005 & 2007

- 3x 30 trial /day - 3x/week - 8 weeks
- based on 1 RM

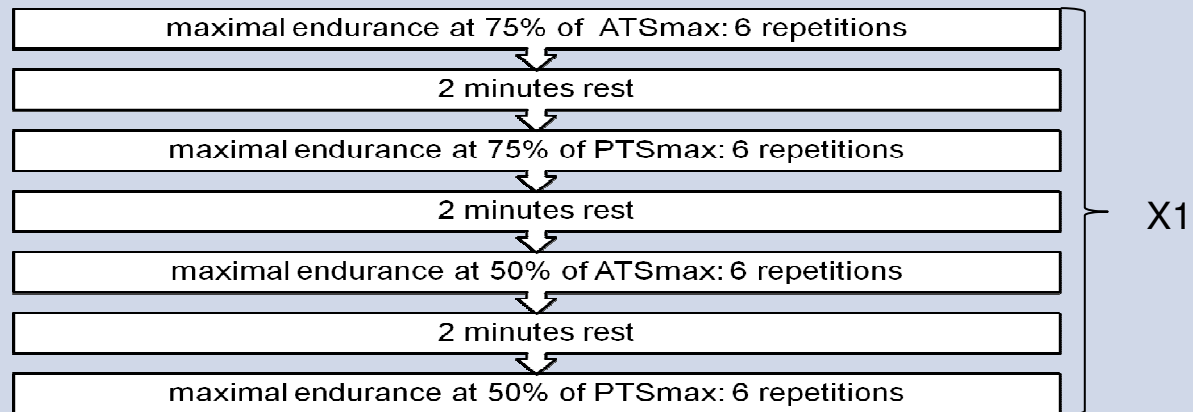
Time	New 1 RM	Level of practice
Baseline – week 1	X	60 % RM
Week 2		80% RM
Week 3	X	80% RM
Week 4		80% RM
Week 5	X	80% RM
Week 6		80% RM
Week 7	X	80% RM
Week 8		80% RM

UZA – 1

Part 1



Part 2



CHU-St-Pierre - 1

- MIP ant 1X
- MIP post 1X
- End ant 1X
- End Post 1X
- 30 repetitions of 75% MIP (1 pression/sec); ant & post
- 75% MIP:
 - 1 sec → 2 sec → 3 sec → 4 sec → ... → max.
 - max → ... → 4 sec → 3 sec → 2 sec → 1 sec

Johan Allouche, Jan Vanderwegen

Take home messages

Tongue strength matters

Intensity matters (overload & volume)

'The' protocol? No

Try and fail but don't fail to try...