Upper-thoracic (tense) breathing pattern: relationship with functional respiratory symptoms (dyspnea) and general distress

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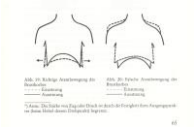
Introduction: breathing pattern

Respiration is a rhythmic, three-dimensional motion of expansion and contraction, as a result of which air flows in and out

- Time components are easiest to quantify and studied most (frequency, pauses, regularity)
- Volume components are studied mostly through its derivative, air flow (ventilation)
- Breathing mechanics is studied as the efficiency to move air
- **Disturbances in three-dimensional form changes** are clinically observed, seem indepent of ventilation, seem relevant to perception of breathing, but are harder to quantify
- **Manual Assessment of Respiratory Movement (MARM)** is a valid procedure to derive quantitative measures of distribution of breathing movement (Courtney & Van Dixhoorn, 2008)

Dysfunctional breathing pattern and thoracic form change



There are various descriptions of a 'tense' or 'faulty' or 'dysfunctional' execution of the form change with breathing:

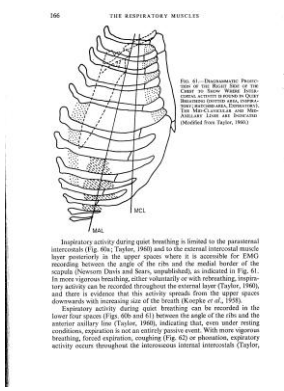
•Thoracic versus abdominal or 'diaphragmatic' breathing
•Paradoxic breathing
•Upper thoracic or gasping breathing
•Thoraco-abdominal asynchrony
•Use of auxiliary respiratory muscles
• Restriction of abdominal muscles
• Lifting of shoulders

These descriptions emphasize the overt appearance, but neglect the pattern of thoracic form change. This was already known in the German rehabilitation tradition. See Parow (upper figure, 1980) and Bergsmann (lower figure, 1977)

What happens in the thorax? Pattern of intercostal muscle activation

Inspiratory activity during quiet breathing is limited to the **parasternals** and the external intercostals posteriorly. There is evidence that this activity **spreads downwards** with inceasing size of breath.

Expiratory activity during quiet breathing can be recorded in the **lower four intercostal spaces**, laterally. With more vigorous breathing (forced expiration, coughing, phonation) activity occurs throughout the internal intercostals, **spreading upwards** (Campbell, 1970)



166 THE RESPIRATORY MUSCLES

Fig. 61.—Diagrammatic Projection of the Right Side of the Chest to Show Where Intercostal Activity is Found in Quiet Breathing. MAL, Mid-Axillary Line; MCL, Mid-Clavicular Line. (Modified from Taylor, 1960.)

MCL

MAL

Inspiratory activity during quiet breathing is limited to the parasternal intercostals (Fig. 60a; Taylor, 1960) and to the external intercostal muscle layer posteriorly in the upper spaces where it is accessible for EMG recording between the angle of the ribs and the medial border of the scapula (Newsom Davis and Sears, unpublished), as indicated in Fig. 61. In more vigorous breathing, either voluntarily or with rebreathing, inspiratory activity can be recorded throughout the external layer (Taylor, 1960), and there is evidence that this activity spreads from the upper spaces downwards with increasing size of the breath (Kuepfer *et al.*, 1958).

Expiratory activity during quiet breathing can be recorded in the lower four spaces (Figs. 60b and 61) between the angle of the ribs and the anterior axillary line (Taylor, 1960), indicating that, even under resting conditions, expiration is not an entirely passive event. With more vigorous breathing, forced expiration, coughing (Fig. 62) or phonation, expiratory activity occurs throughout the intercostals internal intercostals (Taylor,

Lack of sideways expansion

Possibly, when respiratory muscles are activated, **without concomitant increase of ventilation**, e.g in a preparatory phase or in more psychic than physical activation

Expiratory activity limits sideways expansion of the thorax,
While inspiratory activity lifts the upper chest,
Resulting in stiffness and less flexibility in the chest (less functional breathing), increased muscle activity, the pattern of upper thoracic breathing, sense of dyspnea, possibly less effective inhalation of medication

This pattern may be called **dysfunctional,** because it is an inefficient way of contracting and expanding. We quantify it by way of a manual assessment.

Lum (1976) observed this to be typical of hyperventilation patients
Garssen & Rijken (1986), suggested this may be one pathway for complaints
Courtney (2008), found no association with hypocapnia, but (2011) clear association with dyspnea in patients with stress related complaints
Ritz et al (2013) found that voluntary tensing of intercostal muscles led to dyspnea, in particular in anxiety-prone students
Lehrer (in press) found that thoracic breathing specifically was associated with negative mood

Research questions

Is the presence of upper thoracic breathing pattern associated with

- functional respiratory (hyperventilation) symptoms in general (NQ)
- specific respiratory symptoms (dyspnea)
- symptoms of general distress

Do subgroups of patients with stress related complaints differ

- in upper thoracic breathing
- in functional respiratory symptoms in general (NQ)
- in specific respiratory symptoms (dyspnea)
- in symptoms of general distress

Subjects

- Patients, n=208, referred to the private practice for breathing therapy of EA, 2009-2013
- Age: 41.7 ± 16 years, range 10 – 78
- Women 70%
- Average practitioner: more psychic problems, medical diagnosis, musculoskeletal (pain) problems, voice problems, less women

Diagnostic labels

- Tension problems, including burnout n= 76
- Hyperventilation n= 31
- Sleeping problems n=16
- Anxiety n=15
- Headache n=8
- Mixed group n=62 mainly with different medical diagnoses (23), depression (4), fatigue (3), unclassified problems (32)

Therapist Els Anthonissen

Psychomotor therapist, works in psychiatric clinic

Part-time private practice and data collection since 2002, conscientiously and systematically

- Completed education in breathing and relaxation therapy in 2001
- Completed education for teacher in breathing relaxation therapy in 2008
- Teaches at the Centre for Breathing Therapy and in University /post graduate courses in The Netherlands & Belgium

Measurements

- Nijmegen Questionnaire (NQ)
- Respiratory items NQ
- General Distress questionnaire (GDQ)
- Manual assessment Respiratory movement (MARM)

- At intake
- After four sessions
- At completion of treatment

Nijmegen Questionnaire

never=0, 1=rarely, 4=very often.

16 items: range 0-64

4 items represent dyspnea, range 0-16

- Normals: 10.9 ± 7.1 *
- Hyperventilation complaints: 29,5 ± 9,0 **

Comparing normals to HV patients, a sumscore of 20 or higher indicates the dysfunctional domain#, for dyspnea cut-off score = 5

* Data from Han (1998) and Thomas (2005)

** Data from internet study AOS (2011)

\# Jacobson& Truax (1991)

General Distress Questionnaire

GDQ: 16 items

4 items represent movement difficulty

5 items represent fatigue, lack of rest

4 items represent mental unrest

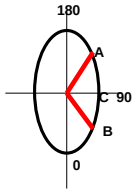
Score: 1=rarely, 4=very often. Sum: 64

- Normals: 23.9 *
- Patients : 34,6

Comparing normals to patients, a score of 28 or higher indicates the dysfunctional domain *

* Bosscher, AOS report 2011

MARM: Manual assessment respiratory movement



Quantification of distribution of breathing movement

Level (average value): A + B / 2

Area= angle AB

Percent ribcage (AC /AB) *100

Both sides, if they differ

No quantification of

Time components: frequency, pauses

Fluency, tightness

Sounds of air passage

Ventilation, tidal volume

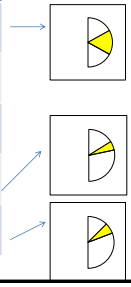
(Ir)regularity, sighs

Scoliosis, kyphosis and lordosis

MARM: values for different groups

Category	MARM level	MARM Area
Breathing therapists (n=67)	90 ± 6.9	58 ± 15.8
Physiotherapists (n=16)	91 7.9	44 10.7
COPD patients (n=35)	103 20.8	42 17.9
Stress / tension patients (n=62)	112 ± 10.2	20 5.4
Hyperventilation patients (n=31, this study)	123 11,9	23,5 7.2

Comparing breathing therapists with hyperventilation patients, the **cutoff for abnormal MARM** is for
Level >102



Reliability and validity of MARM (2008)

12 subjects, experienced in breath control, performed 9 different situations: sitting normal, slump and upright, each breathing normal, abdominal and thoracic

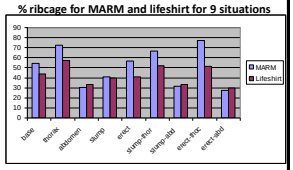
Two assessors performed MARM, while monitored with Lifeshirt

High inter examiners reliability for MARM %ribcage (0.84)

Correlations Lifeshirt and MARM: %ribcage 0.60

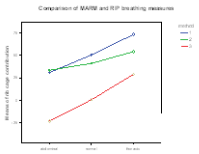
Breathing and posture situations were differentiated well; MARM did better than Lifeshirt

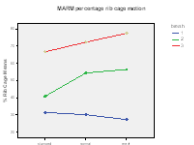
Eta squared 0.94 versus 0.62



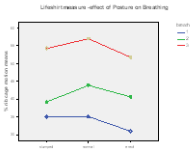
Courtney,R.; van,Dixhoorn J.; Cohen,M. Evaluation of Breathing Pattern: Comparison of a Manual Assessment of Respiratory Motion (MARM) and Respiratory Induction Plethysmography. Appl. Psychophysiol.Biofeedback, 2008, 33-2: 91-100

Measurement of abdominal, normal and thoracic breathing by MARM and Lifeshirt





Breath 1= abdominal, Breath 2=normal, Breath 3= Thoracic



Method 1= MARM percentage rib cage,
Method 2=Lifeshirt percentage rib cage,
Method 3= MARM balance

MARM is more sensitive to upper thoracic breathing than Life shirt

Results

	M	SD	Range	Abnormal (%)
NQ	22,5	9,2	3, 49	59
Dyspnea	5,2	3,7	0, 16	54
GDQ	31,7	9,9	10, 55	68
Marm	113,8	13,4	86, 147	76

For all subjects

The presence of upper-thoracic breathing is related to dyspnea items, to NQ, less so to NQ minus dyspnea items, but not to GDQ

	Normal marm	Abnormal marm	p
NQ	16,7 8,3	24 8,6	< 0.000
Dyspnea	2,6 2,8	6,0 3,6	< 0.000
NQ-dyspnea	14,1 6,8	17,9 6,3	<0.001
GDQ	32,6 8,5	31,4 10,6	ns

Marm normal / abnormal

Patients with different stress related complaints differ in upper-thoracic breathing

	Marm	Abnormal (%)
Mixed group	111,8 14	69
Hyperventilation	123,2 11,9	97
Anxiety	114 11,6	80
Tension	116 11,6	85
Sleeping problems	99,4 7,3	38
Headache	103,9 9,5	50
	F=9,9 p< 0.000	X^2=27,9 p< 0.000

Hyperventilation group has almost always upper thoracic breathing, followed by tension, anxiety and mixed group, with sleeping problems and headache the least

Patients with different stress related complaints differ in functional respiratory complaints (NQ) and dyspnea

	NQ	Abnormal (%)	Dyspnea	Abnormal (%)
Mixed group	23,5 7,7	63	5,2 3,6	56
Hyperventilation	30,8 8	90	8,6 3,6	89
Anxiety	24,1 10,1	60	5,4 3,6	53
Tension	20,9 8,3	55	4,7 3,3	48
Sleeping problems	13,8 7	31	2,4 2,8	33
Headache	11,5 3,2	0	2,5 2,4	25
	F=14,3 p<0.000	X^2=30 p< 0.000	F=8,8 p<0.000	X^2=19,7 p< 0.001

Hyperventilation group is mostly abnormal, followed by mixed group and anxiety, with least abormality in sleeping problems and headache

Patients with different stress related complaints only slightly differ in general distress

	GDQ	Abnormal (%)
Mixed group	**35,2 7,9**	**86**
Hyperventilation	**32,7 10,2**	**68**
Anxiety	**28 11,8**	**47**
Tension	**30,1 10,2**	**58**
Sleeping problems	**33,9 9,6**	**88**
Headache	**26,9 8,3**	**63**
	F=2,5 p<0.05	X^2=15,5 p< 0.01

Patients with sleeping problems and mixed group score highest, followed by hyperventilation, headache and tension problems, anxiety scores lowest

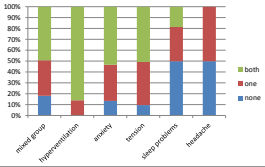
Discussion

Thoracic form change with breathing is a relevant topic:
scientifically, to study perception of breathing,
clinically, for treating respiratory discomfort

Dysfunctional breathing may be defined as a combinaton of abnormalities in breathing movement and elevated functional respiratory complaints

- Upper thoracic breathing is related to functional respiratory complaints, (including dyspnea) and not to general distress
- It occurs predominantly among the hyperventilation subgroup, but overlaps with anxiety, tension and the mixed group

Presence of abnormal Marm and NQ for subgroups



Limitations

- Data from a single therapist. Probably consistent in manual assessment but replication by other therapists is needed
- Patients with pain and with lung diseases are lacking. They would be expected to show upper thoracic breathing and should be included
- Treatment outcome and thus responsiveness and reversibility of breathing pattern and complaints is not analysed