

# THE EFFECT OF POSTURE ON THE ROLE OF PECTORALIS MAJOR AND LATISSIMUS DORSI MUSCLES IN EXPIRATION IN TETRAPLEGIA

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## SUMMARY

This study was designed to examine the effect of posture on forced expiration as reflected in phasic electromyographic activity in accessory expiratory muscles in tetraplegic subjects with complete lesions between the fifth and eighth cervical segments. In order to determine the effect of posture on the action of the clavicular head of the pectoralis major muscle and the latissimus dorsi muscle during forced expiration, the subjects were studied in two test positions, support sitting and supine lying.

Electromyographic examination of the above mentioned muscles in eight tetraplegic subjects showed changes in electrical activity in the clavicular portion of the pectoralis major muscle when the subjects were studied in the supine position. Four out of eight subjects showed evidence of an increase in EMG activity in the supine lying position. When the muscle was tested with the patient in the supported sitting position it failed to demonstrate a significant increase in electromyographic activity during forced expiration.

We concluded therefore that the role of the clavicular portion of the pectoralis major muscle during expiration in tetraplegia is posture dependent. These findings have important therapeutic implications: specific training programmes to increase the strength and endurance of this muscle should be conducted with the subject in the correct position. The action of the latissimus dorsi muscle was not significantly influenced by the postural changes during forced expiration.

## INTRODUCTION

Tetraplegics with traumatic transection of the spinal cord between the fifth and eighth cervical segments lose their intercostal and abdominal contribution to respiration. The resultant neuromuscular respiratory insufficiency exposes the patient to serious respiratory complications such as retention of secretions, lung collapse and pneumonia<sup>1,2,3,4,5</sup>.

A distinctive feature of the respiratory dysfunction in tetraplegics is the marked reduction in expiratory force because of paralysis of all the known muscles of expiration. This causes severe impairment of the patient's ability to cough, an important mechanism in shifting secretions.

Several studies discuss the physiological and pathological sequelae of ventilatory muscle paralysis in tetraplegia but there is very little known about their mechanism of expiration<sup>6,7,8,9,10</sup>. Goldman *et al* demonstrated tonic electromyographic (EMG) activity in the abdominal muscles while normal phasic inspiratory activity was present in the diaphragm. This was due to movement in the abdominal wall caused by a stretch reflex mediated at the spinal cord. This was present only during inspiration and therefore had no effect on the expiratory phase of respiration<sup>11</sup>.

De Troyer *et al* recently detailed the mechanism of forced expiration in tetraplegics with lesions below the fifth cervical segment when they studied the action of the clavicular head of the pectoralis major and latissimus dorsi muscles<sup>9</sup>. Increased electromyographic activity in the clavicular head of the pectoralis major muscle occurred synchronously with forced expiration with a concomitant reduction

in the anterior-posterior diameter of the upper rib cage. Similar electrical activity was recorded for latissimus dorsi muscles during forced expiration<sup>9</sup>. Strengthening the accessory muscles of expiration could probably serve an important prophylactic modality in the overall management of pulmonary problems as encountered with the lesions described above<sup>13</sup>. Carter highlights the importance of preventative therapy. "Certainly there are few, if any, areas elsewhere in the field of medicine that require treatment prior to the onset of pathology as does the respiratory muscle weakness in spinal cord injury"<sup>2</sup>.

In order to achieve optimal training results the patient should be exercised in a position which would ensure maximal recruitment of the muscle fibres. The selection of suitable training positions is important because it has been shown that the accessory inspiratory muscle performance in tetraplegic subjects is posture dependent<sup>12</sup>.

Estenne found an increase in the amplitude of inspiratory EMG activity when examination position of patients was changed from supported sitting to supine<sup>12</sup>.

Although the influence of posture on accessory inspiratory muscle action in tetraplegics has been investigated electromyographically by de Troyer, no systematic studies of the effect of posture on accessory expiratory muscle performance have been carried out<sup>9</sup>. Therefore, this study was designed to examine the effect of posture on forced expiration as demonstrated by electromyographic activity in the clavicular part of the pectoralis major muscle and latissimus dorsi muscle in order to identify the optimal training position.

## METHOD

### Subjects

We studied eight randomly selected tetraplegics with functionally complete transection of the cervical cord as evidence by clinical examination. All had suffered traumatic fracture dislocation of the cervical spine between the fifth and eighth cervical vertebrae as evidence by spinal radiographs. The post-injury period in all eight patients was least four months.

A preliminary inclusion interview eliminated subjects with respiratory disease as evidenced by lung radiographs and chest physical examination.

This study population consisted of seven males and one female with ages ranging from eighteen to forty-five years, as shown in Table I. An informed consent was obtained from all the patients. The study was reviewed and approved by the Ethics Committee of the Faculty of Medicine at the University of Natal.

TABLE I: DEMOGRAPHY OF PATIENTS

PATIENT	AGE	LEVEL OF INJURY	POST-INJURY PERIOD
1	27	C6	6 months
2	24	C6	4 years
3	25	C6	1 year
4	45	C6	7 months
5	26	C6	4 years
6	30	C6,7	3 years
7	38	C7	3 years
8	18	C7	4 months

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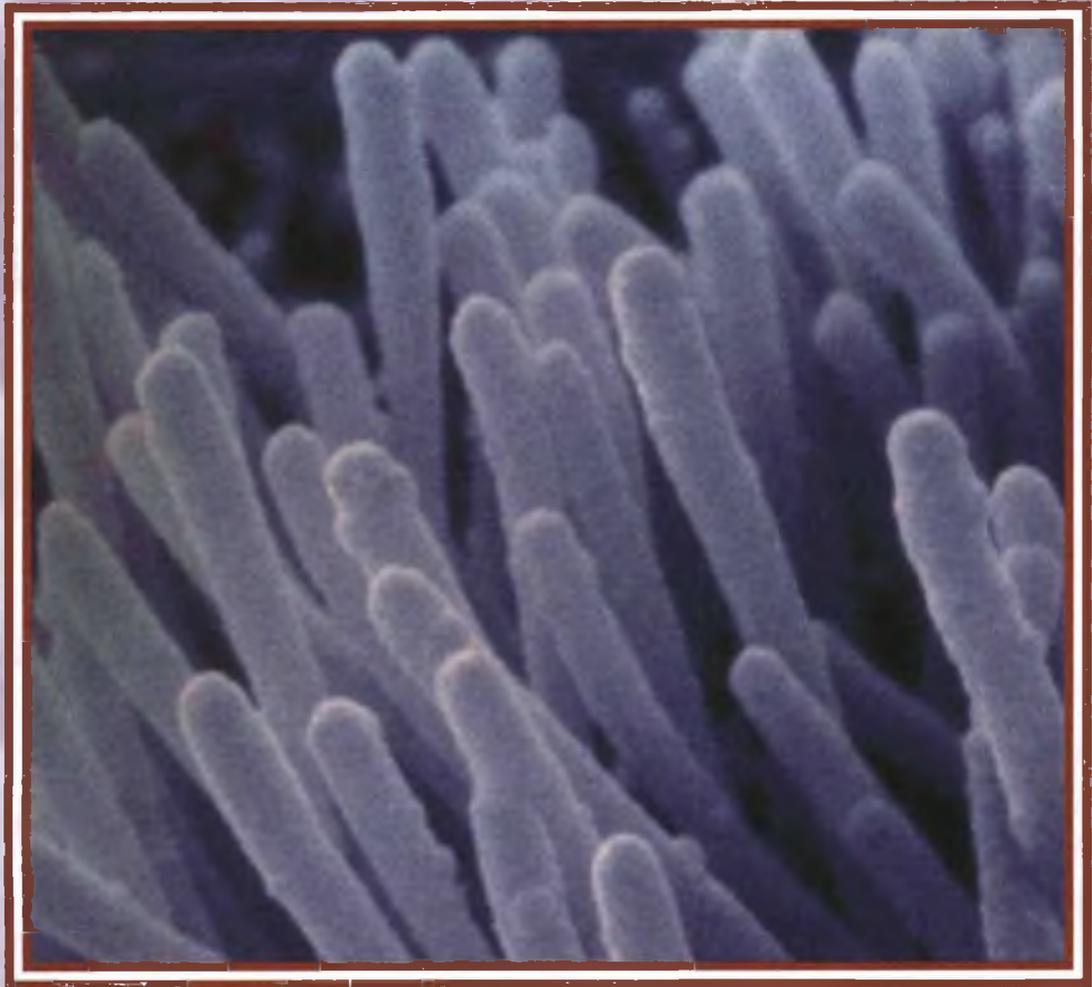
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(1) Lewis RAL, Gibson GJ, Geddes DM. Respiratory Medicine. Published by Bailliere Tindall, London, 1990: Page 732. (2) Norris Melville G, Sealy S, Sealy C. Tracheobronchial function in health and disease. *Respiration* 40 (1980): 329-336 (3) Today's drugs. *Br. Med. J.* June 5 (1971): 581-581 (4) Houben JIG, van Rossum JM. Drug-Targeting door middel van combinatie-therapie. *Journal for Drug Therapy and Research*, September 1992: 213-218 (5) Taskar VS, et al. Effect of bromhexine on sputum mucin levels in lower respiratory infections. *Respiratory Medicine*, 86 (1992): 157-160 (6) Martindale. The Extra Pharmacopoeia, 29th Edition.



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## Electromyographic examination

The electrical activity of a specific muscle was studied by inserting a recording needle electrode directly into the muscle. The bioelectric potential that was recorded by this electrode was amplified and then displayed on a cathode ray oscilloscope for visual analysis and fed through a loudspeaker system so that it could be monitored acoustically. A permanent photographic record of the oscilloscope trace can be made, if desired.

A specialist neurologist from the Department of Neurology at the Medical Faculty of the University of Natal assisted with the electromyographic examinations and was responsible for the insertion of the needle electrode. Each patient was examined in two test positions, ie sitting (with support) and in supine. The clavicular head of the pectoralis major muscle and latissimus dorsi muscle were examined with the aid of the Disa 2000 EMG machine. With the patient in the supine position and the upper limb on the side of the examination adducted and internally rotated, the clavicular head of the pectoralis major muscle was identified.

Using a sterile technique and with the muscle relaxed, a concentric needle electrode was inserted into the belly of the muscle approximately two centimeters below the mid-position of the clavicle. The latissimus dorsi muscle was studied with the needle electrode inserted in the posterior axillary fold. Recordings of EMG activity were obtained from the study positions during both tidal breathing and forced expiration.

The study design required three EMG recordings from each muscle:

- The first recording presented EMG activity of the muscle while the patient was at rest tidal breathing in the supine position.
- The second showed EMG activity while the patient was in the supported sitting position and performing forced expiration with the aid of the PFLEX trainer. This training device is an effective and economical apparatus designed to offer resistance to either inspiratory or expiratory air-flow.
- The third recording showed EMG activity in the accessory muscles while the patient was performing forced expiration with the aid of the PFLEX trainer in the supine position.

The three recordings from each muscle were arranged in panels one below the other according to the above order (Fig 1-3). The amplitude and "fullness of the interference pattern", as recorded by the EMG, constituted the criteria for determining the optimal functioning positions<sup>14</sup>.

## RESULTS

The clavicular head of the pectoralis major muscle showed distinct phasic activity in all eight patients during forced expiration. Figure 1 shows the pattern of phasic EMG activity in the clavicular head of the pectoralis major muscle during forced expiratory in patient number four.

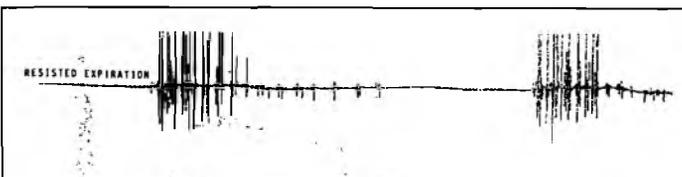


Figure 1: Phasic motor unit activity for clavicular head of Pectoralis Major during forced expiration with the subject in supine

Four patients showed greater electrical activity in this muscle when studied in the supine position:

Figures 2 and 3 show the representative changes in phasic EMG activity when the positions of three patients were changed from the sitting to the supine lying position. This activity was not present during relaxed tidal breathing, but became apparent as ventilation increased. The increase in phasic EMG activity in the supine position occurred simultaneously with the forced expiratory phase and tapered off abruptly at the end of the expiratory effort.

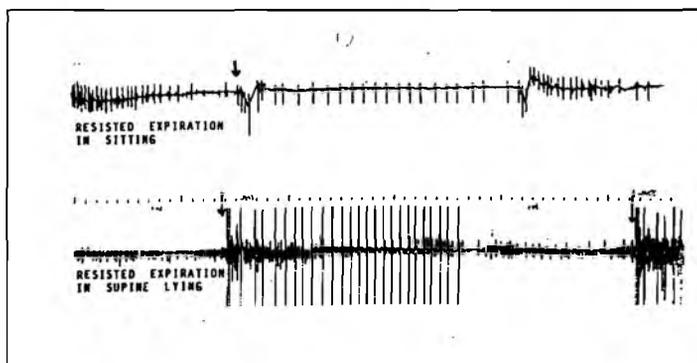


Figure 2: Phasic motor unit activity in clavicular part of Pectoralis Major during forced resisted expiration with the subject in sitting and in supine

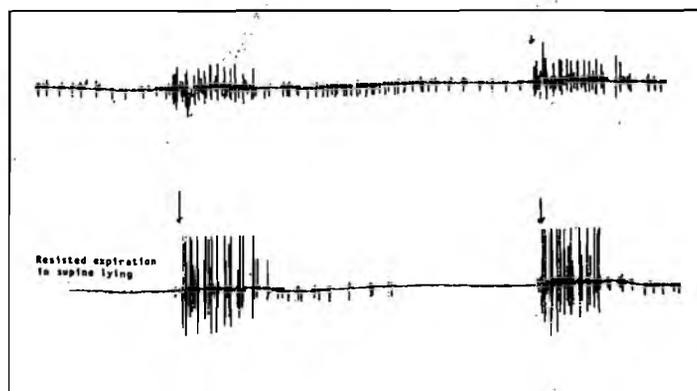


Figure 3: Phasic motor unit activity in clavicular part of Pectoralis Major during forced resisted expiration with the subject in sitting and in lying

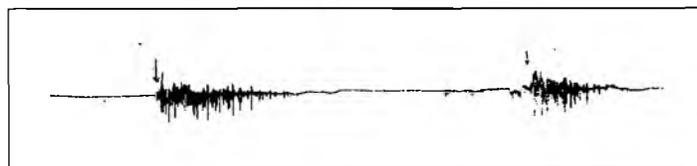


Figure 4: Phasic motor unit activity in Latissimus Dorsi during resisted expiration with the subject in supine

The analysis of the EMG recordings from the latissimus dorsi muscle showed distinct phasic activity in five patients. The changes in electrical activity occurred simultaneously with forced expiration as shown in Figure 4. Electromyographic activity in latissimus dorsi muscle was not affected by changes in posture. EMG recordings from latissimus dorsi in the remaining three patients showed inconsistency in phasic activity.

## DISCUSSION

Traumatic injuries of the cervical spine constitute fifty per cent of spinal injuries<sup>15,16,17</sup>. The resultant neurological deficit unaccompanied by immediate fatality, results in tremendous morbidity and consequent later mortality<sup>2,5</sup>.

The principal cause of death is respiratory insufficiency, secondary to aspiration pneumonia. If accessory ventilatory muscles could be recruited for expiration this may help alleviate the problem. De Troyer noted the recruitment of pectoralis major muscle and latissimus dorsi muscle during forced expiration<sup>9</sup>. Additionally, the clavicular head of the pectoralis major muscle receives its nerve fibres from the (fifth, sixth and seventh) cervical segments unlike the sternocostal portion which would be paralysed, due to its innervation at a lower level.

The influence of posture on the expiratory force of the clavicular portion of the pectoralis major muscle has not been studied. De Troyer *et al* only studied patients in the supported sitting position<sup>9</sup>. Our study has shown that, in four out of eight subjects, a significant increase in EMG activity occurred in the supine position compared to the readings obtained in the support sitting position.

We recommend that in patients with tetraplegia, an accurate assessment of ventilatory muscle dysfunction be undertaken, if necessary, with electromyography. When a decision for ventilatory muscle training is made then the correct posture for maximum benefit of the clavicular portion of the pectoralis major muscle needs to be determined. Thereafter ventilatory muscle training should employ this position to ensure the best results.

## CONCLUSION

The supine lying position was associated with the ability to generate greater changes in EMG activity in the clavicular portion of the pectoralis major muscle during forced expiration in four tetraplegic subjects. These findings stress the need for the selection of correct starting position for accessory expiratory muscle training in tetraplegia.

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## Reviewer's Note

This article covers an interesting topic. The results are not conclusive however, because of the small sample size. A larger number of subjects showing a consistent increase in EMG activity would give more credibility to the conclusions drawn.

As the subjects used in this study would have some action of the diaphragm, other tests could also have been done. Firstly, a measure of the peak expiratory flow rates in the subjects may have been useful. Secondly, the ratio of FEV1 to FVC would be valuable in this respect, and would serve to control nuisance variables such as sex, age range etc.

J Mitchell

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- 3 hour theory paper
- Practical techniques exam.
- 1 hour clinical exam.
- Project

A candidate must pass all parts of this exam with a 60% minimum. A certificate is issued by the National Manipulative Therapists Group.

## ERRATUM

Professional Board for Physiotherapy

In *Physiotherapy*, November 1992, Volume 48 No 4 page 63 it was stated that Margaret Anne Beattie completed her MBA studies at the Pretoria University. This is an editorial error and should have read "Commenced her MBA studies at the Pretoria University". Any misrepresentation of the facts was unintentional.

The Editor