THE ROLE OF ACCESSORY RESPIRATORY MUSCLE IMPAIRMENT IN THE MECHANISM OF RIB FRACTURE IN ROWERS

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INTRODUCTION

The purpose of this study was to investigate the dual function of Serratus Anterior during 2000m rowing time trials relative to the mechanism of rib fracture previously reported in competitive rowers. The research presented in the literature has not conclusively established one mechanism of injury in the etiology of rib fracture, however, the most common location reported in the rowing and golf communities has been on the postero-lateral aspects of ribs 5-9**.** Serratus Anterior has been shown to be integral during several phases of the rowing stroke, as well as during respiration (Sliwinsky, 1996) with deep inspiration for increased ventilatory capacity by way of raising and expanding the rib cage (McConnell 1997, Smith 1994). Impaired function of the SA may be one risk factor for the development of rib fractures, an injury that is pervasive in the competitive rowing community with incidences reported as 32.6% in female rowers and ratio of 1.58:0.85 F:M (Hickey, 1997). The intent of this study was to obtain normative data related to pathomechanics of rib fracture in rowers in an effort to establish evidenced risk factors to augment preventative training techniques and rehabilitative strategies.

METHODS

The subjects included asymptomatic sweep rowers from California State University Long Beach rowing team and normal age-matched controls (mean age 22.9 SD 4.65, $P<0.05$) including 24 untrained rowers (UR,<3 yrs training, 14 females, 10 males), 9 trained rowers (TR>3 years, 5F:4M), and 12 controls (NR, 5F:7M). 1 subject had a prior history of rib fracture, postero-lateral rib 7 that was well healed by x ray. Subjects were cleared for participation by a physician and surveyed for exclusion secondary to injury, medical, or orthopedic pathology. Asthmatic rowers' (AR, N=4) data were analyzed separate from non-asthmatic rowers (NAR, N=29). The rowers participated in three test sessions. The first and second testing sessions were 1 week apart, at the same time of day, after 1 week of heavy work load training. Tests included a 2000m timed rowing trial (concept II ergometer) with measures collected of pre(I) and post(F) time trial: Heart rate (I, F), Forced Vital Capacity(I, F), and lactate measurement (I, F1min, F3 min). Additional measures of Maximum Inspiratory Peak Pressures (MIPP), MIPP80 (time maintaining 80% peak inspiratory pressures), and Maximum Voluntary Ventilation (MVV) for measures of accessory inspiratory muscle strength (MIPP, Rochester, 1988) and endurance (MVV, MIPP80) were collected at the second testing session. The final set of measures were electroneuromyography, and assessed innervation status and injury of Long Thoracic Nerve (LTN). The control group participated in tests 2 and 3 as above. Diagnostic EMG, was conducted by a licensed electrodiagnostician on subjects with history of rib fracture or determined neurologic impairment.

RESULTS AND DISCUSSION

The ENMG data demonstrated that while gender may influence the chronaxies (F 0.039, SD 0.024, M 0.24 SD 0.19 P<0.05) and sport development may influence the amplitude (peak to baseline mean R 4.5 SD 0.7, NR 2.14 SD 1.38, p=0.057), the subjects were neurologically intact. The time means data (p<0.05) indicated that the subjects were grouped appropriately R (7-7.5 min) (<) than NR (>9:30), TR(7-7:30) < UR (7:30-8), and AR (8-8:30)> NAR (7-7:30). All subjects utilized similarly amplified cardiovascular response. However, averaged MVV data indicated TR demonstrated proportionally higher increases in ventilatory volume (TR 35.4 to 37.9 BPM, 106.4 to 116.14 L/min), while UR increased rate and volume of ventilation, (UR 40.4 to 47 BPM , 98.8 to 184.3 L/min), as did AR (33 to 44 BPM, 98 to 108 L/min MVV), and NAR increased primarily volume (42.4 to 39 BPM, 101 to 157 L/min). Significant increases in lactate values from baseline were higher R>NR, TR > UR AR>NAR post erg. Significant drop of post erg MIPP80 was observed in all groups: 37%UR, 40%TR, 41%NR, AR 60%, NAR 39%. TR v. UR had no differences in baseline MIPP however, TR demonstrated greatest post erg decrease (TR 19.2% v. UR 1.8%). While all groups decreased in the MIPP 80 times, the TR demonstrated in the face of normal FVC and respiration, severe compromise in post erg MIPP.

SUMMARY

These data may suggest that at maximum fatigue trained rowers, controls, and asthmatic rowers may be at the highest risk for fatigue fracture secondary to impaired accessory respiratory muscle strength and endurance contributing to excessive rib bending forces leading to rib fracture. At end stage maximum fatigue, the SA may not maintain the stroke necessitated eccentric resistance, isometric stabilization at the catch, or may demonstrate impaired muscle length/tension relationship. These values may be underestimated as they lacked torsional and side bending forces of sweep rowing. Research has supported skeletal muscle warm-up phenomena in MIPP/MIPP 80 data, (Volianitis, 2000), increased tidal volume with entrainment (Steinacker, 1993), decline in inspiratory mm endurance after high intensity workload (Ker, 1996), and correlated workload fatigue with respiratory fatigue and decrease in MIPP values (McConnell, 1997). This data and previous literature implicate the necessity for pre-season workload respiratory muscle assessment, warm up, and inspirometry training for decreased risk of fatigue fracture, improved performance, and rehabilitative efficacy.

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