Gender-Specific Concussion Risk Management: Should We Take Another Look at Use of Mouth Guards?

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Background

Decreased neck strength is a predictor for sport-related concussions (SRC). Females are not only more susceptible for SRC, but they have less neck strength with difference muscle activation patterns compared to males. Recent evidence suggests a significant negative relationship between neck strength/endurance and risk levels for concussion. (1,2) Greater neck strength and activating the neck muscles to brace for impact are both thought to reduce risk of concussion during a collision by attenuating the head's kinematic response after impact. (3, 4, 5) There continues a great need to augment gender specific training programs or the addition of appliances that target neck strengthening in females. (6,7)

Purpose

The purpose of our study was to investigate gender-specific immediate cervical & upper body muscle strength and endurance responses to optimal alignment of the jaw using as customized mouth guard.

Research Design

Cohort Study Design

Methods

Setting

University Outpatient Clinic

Participants

32 healthy participants (14 females/18 males) over 18 yrs. were sampled by convenience. Inclusion criteria: normal cervical spine AROM, no recent head or neck trauma or surgery. Exclusion criteria: active cervical pain and any cervical spine postural abnormalities.

Participants were tested by a physical therapy orthopedic specialist, using standardized assessments of grip strength and head-neck directional positions for strength and endurance including extension, flexion and rotation. Participants were tested in each condition without and then with a customized interocclusal appliance or mouth guard in place by a neuromuscular trained dentist.

Data Analysis

SPSS vs. 26 was used for descriptive statistics, paired T-Tests, and 2-way repeated measures ANOVA to explore differences at p = 0.05 with a Greenhouse-Geisser correction factor.

Primary Outcomes

- **Head-Neck Strength:** Muscle strength as measured by isometric peak force on MicroFit® gauge (3 sec)- w & w/o MG
- **Head-Neck Endurance:** Muscle endurance as timed sustained contraction to maintain head position- w & w/o MG
- **Grip Strength** : Bilateral grip strength w/Jamar® dynamometer - w & w/o MG

Figure 1: Cervical spine muscle strength & endurance Protocol

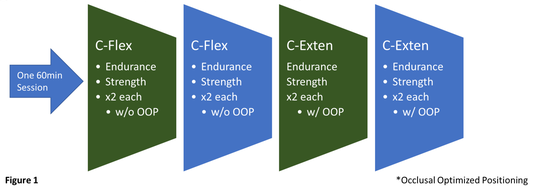

Figure 1 *Occlusal Optimized Positioning

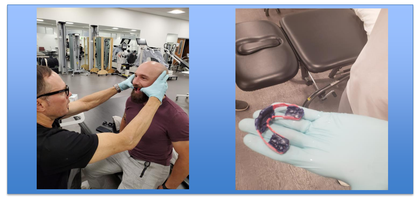

Figure 2: Optimal Head –Jaw Positioned w/Mouth Guard.

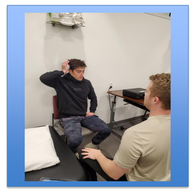

Figure 3: Head in neutral position in sitting for strength testing.

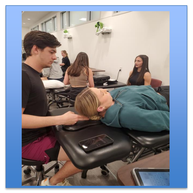

Figure 4: Head position for cervical muscle endurance testing.

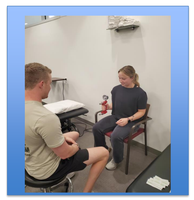

Figure 5: Bilateral grip strength tested with Jamar® dynamometer.

Results

There were significant group differences in muscle endurance: Deep Neck Flex Endurance Test-Supine, t= -3.149, p= 0.009 and Grip Strength, t = -3.615, p < .001. Also, significant differences were found in neck directional strength based on Condition ($F_{(1,5)}$-6.849,p = 0.001) and Group ($F_{(1,1)}$ = 27.508, p < 0.001).

	Group & Conditions Differences				
	Females (n = 14)		Males (n = 14)		
Age (sd)	22.186 (2.282)		33.034 (13.839)		
BMI (sd)	23.1 (7.8)		26.9 (3.1)		
	Without MG*	With MG	Without MG	With MG	p-values**
Combo Grip Strength (kg)	192.154 (21.578)	187.061 (25.243)	261.328 (30.603)	258.244 (31.901)	C: p = .334 G: p < .001
Flexion (kg-force)	13.269 (4.570)	14.677 (5.908)	24.4833 (6.973)	26.539 (7.219)	C: p = .020 G: p < .001
Extension (kg-force)	17.485 (9.584)	20.048 (8.075)	30.983 (10.426)	32.744 (9.583)	C: p = .007 G: p= .021
R-Side Flexion (kg-force)	14/754 (5.057)	15.030 (8.478)	26.972 (7.860)	28.300 (8.196)	C: p = .421 G: p < .001
L-Side Flexion (kg-force)	15.354 (5.297)	17.008 (6.212)	26.711 (8.481)	30.078 (8.656)	C: p = .002 G: p < .001
R-Side Rotation (kg-force)	13.123 (4.419)	16.292 (7.447)	24.811 (8.266)	28.328 (8.065)	C: p = .001 G: p < .001
L-Side Rotation (kg-force)	13.123 (4.648)	15.323 (6.629)	24.956 (9.249)	28.700 (8.941)	C: p = .001 G: p < .001
Flexion Endurance (sec)	42.69 (20.09)	53.25 (24.90)	59.07 (25.39)	92.03 (57.77)	C: p = .007 G: p= .021
*MG = Mouth Guard **C = Condition, G = Gender Group, Alpha Level = p <.05					

Table 1: Group (G) and Condition (C) Differences

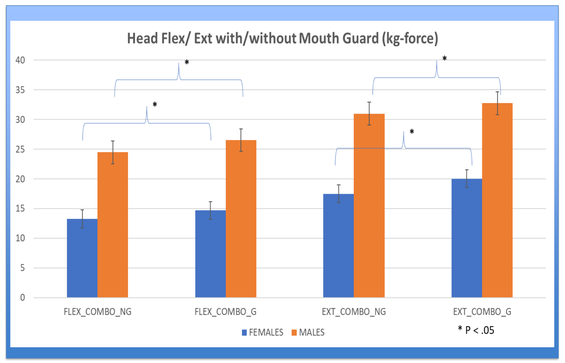

Figure 6: Differences for Head Flexion /Extension

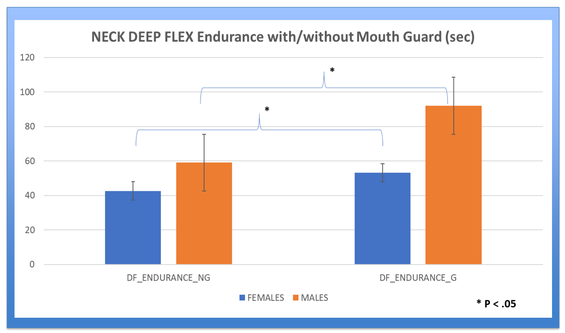

Figure 7: Differences for Neck Deep Flexor Endurance

Conclusions

Female participants showed overall lower neck strength, endurance, and grip strength with and without the mouth guard compared to males. However, both gender groups increased their strength and endurance proportionally, with repeated measures indicating the mouth guard condition as the overall indicator for the improvements ($p < 0.05$).

Clinical Relevance

Preliminary findings strongly suggest that the use of a customized mouth guard is a beneficial interocclusal orthotic to immediately increase neck strength and endurance in both genders. However, the addition of a customized mouth guard to neck strengthening protocols could be needed especially with females to improve neck strength and therefore decrease the risk of sport-related concussions.

This pilot effort also highlights the need for a multidiscipline approach to comprehensive concussion risk management in a patient – centered model.

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