Visuomotor Training for Injury Risk Reduction among College Football Players

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BACKGROUND AND PURPOSE

- Football players sustain ~ 1.2 million injuries per year, most of which are musculoskeletal sprains and strains[1]
  - Visuomotor reaction time (VMRT) is an important component of neuromuscular responsiveness and injury risk
    - Slow VMRT has predicted musculoskeletal sprains and strains sustained by college football players[2]
    - VMRT training has been reported to reduce risk for concussion occurrence among college football players[3]
  - Imposition of a postural stability challenge during VMRT testing may have value for injury risk assessment[4]
  - Recent reports have documented that concussion history is also a risk factor for sustaining any type of injury[5]
- The purpose of this study was to assess the possible benefits of a pre-season training program that presented various types of visuomotor and postural balance challenges.

PARTICIPANT CHARACTERISTICS AND PROCEDURES

- 49 NCAA Division I Football Championship Subdivision players assessed prior to first pre-season practice session
  - No VMRT Training (n=36): 19.9 ±1.1 years; 101.33 ±21.18 kg; 185.14 ±5.62 cm
  - VMRT Training (n=13): 20.1 ±1.4 years; 105.84 ±19.57 kg; 188.16 ±4.69 cm
- Dynavision D2™ system (Dynavision International, West Chester, OH) used for 60-s testing/training trials
  - Test 1: Proactive mode – target button illuminated until hit, followed by illumination of next target button
  - Test 2: Reactive mode – ≤750 ms to hit target button while reading scrolling text on LCD screen
  - Test 3: Reactive mode – simultaneous maintenance of bilateral postural balance on "BOSU" device
- VMRT training participants completed a total of 9 training sessions over a 3-week period
  - Week 1: 3 Proactive mode training sessions (two 60-s trials per session)
  - Week 2: 3 Reactive mode training sessions (two 60-s trials per session)
  - Week 3: 3 Reactive mode - BOSU training sessions (two 60-s trials per session)
- Post-training VMRT tests completed at end of 3-week training period using same procedures

- Electronic documentation system used for injury surveillance throughout pre-season practices and 12 games
  - Injury defined as any sprain, strain, or concussion requiring evaluation and treatment (wrist/hand excluded)
- Proactive performance represented by average response time (ms) and Reactive performance by total hits
  - Analyses also performed to assess performance changes for each of 5 target button concentric rings
    - Average elapsed time (ms) potentially confounded by failure to hit outer ring buttons in Reactive mode
      - Number of hits for 60-s test more valid as an indicator of Reactive mode performance capability than VMRT
- Data analysis procedures:
  - Cross-tabulation analysis performed to assess association between risk classification and injury occurrence
    - Receiver operating characteristic analysis used to establish cut-points for VMRT performance values
  - Paired t-tests used to analyze differences between pre- and post-training performance values

RESULTS

- A total of 18 injuries were sustained by 17 of the 49 players (1 player sustained 2 injuries; Tables 1-4)
  - No difference in injury incidence between players who were starters (41%) and those who were non-starters (42%)
  - 2.7 X more injuries sustained by untrained players (42%) compared to players who completed VMRT training (15%)
- Significant performance improvements evident for both Proactive mode VMRT and Reactive mode hits (Tables 5 & 6)
  - Proactive mode Outer Ring (4 & 5) to Inner Ring (1 & 2) VMRT ratio (O/I) demonstrated significant improvement:
    - Pre-training O/I = 1.63 ±0.17; Post-training O/I = 1.44 ±0.13 (t_{12}=3.97; p=.002)
  - Reactive mode Ring 4 performance associated with injury occurrence, with 2 alternative prediction model cut-points
    - Baseline values for untrained players combined with post-training values for trained players used for analysis
      - ≤ 5 hits: $\chi^2(1)$=2.94; p=.081; Sensitivity = 53%; Specificity = 72%; OR=2.88 (90% CI: 1.03, 8.04)
      - ≤ 11 hits: $\chi^2(1)$=3.60; p=.055; Sensitivity = 88%; Specificity = 63%; OR=4.50 (90% CI: 1.13, 17.82)
- Reactive-BOSU performance improved by training, but association with injury weaker than standing on firm surface
  - Baseline hits for players who did not perform VMRT training: Median = 35.5 (Range 11-61); Mean = 36.67 ±11.50
  - Pre-training hits for players who completed VMRT training: Median = 41 (Range 21-67); Mean = 41.85 ±11.58
  - Post-training hits for players who completed VMRT training: Median = 53 (Range 37-75); Mean = 54.92 ±12.15

Table 1. High-Risk vs. Low-Risk Groups

Starter	Injury	No Injury	Total
Yes	7	17	24
No	10	15	25
Total	17	32	RR= 0.99

$\chi^2(1)$=0.63; p=.310; OR=0.62 (90% CI: 0.23, 1.68)

Table 2. High-Risk vs. Low-Risk Groups

Training	Injury	No Injury	Total
No	15	21	36
Yes	2	11	13
Total	17	32	RR= 2.71

$\chi^2(1)$=2.91; p=.083; OR=3.93 (90% CI: 0.99, 15.64)

Table 3. Injury Incidence Within Groups

Starter	No Training	Training
Yes	41% (7/17)	0% (0/7)
No	42% (8/19)	33% (2/6)
Total	42% (15/36)	15% (2/13)

Table 4. Injuries

Ankle Ligament Sprain	7
Knee Ligament Sprain/Rupture	2
Hamstring Strain	3
Shoulder Subluxation/Separation	2
Concussion	4

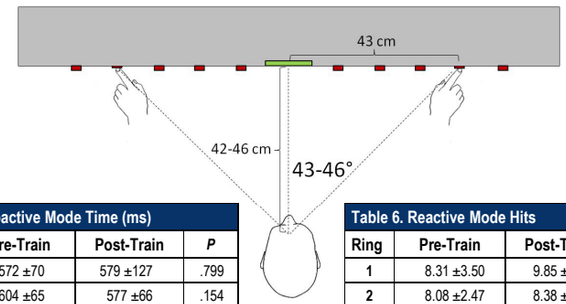

Table 5. Proactive Mode Time (ms)

Ring	Pre-Train	Post-Train	*P*
1	572 ±70	579 ±127	.799
2	604 ±65	577 ±66	.154
3	681 ±92	632 ±89	.135
4	859 ±113	714 ±63	<.001
5	1052 ±175	932 ±155	.014
All	754 ±86	687 ±86	.007

Table 6. Reactive Mode Hits

Ring	Pre-Train	Post-Train	*P*
1	8.31 ±3.50	9.85 ±2.94	.122
2	8.08 ±2.47	8.38 ±3.18	.122
3	14.31 ±5.38	18.08 ±4.63	.032
4	9.77 ±4.59	15.23 ±6.41	.002
5	4.38 ±3.38	6.38 ±3.89	.115
All	44.85 ±14.08	57.92 ±13.60	<.001

CLINICAL RELEVANCE

- Previous research has associated Proactive VMRT ≤ 85 hits (≥ 705 ms) with injury in college football (OR=2.3)[6]
  - 94% of our untrained players (34/36) had ≤ 85 hits at baseline testing and 41% (14/34) sustained injury
    - All 4 concussions were sustained by players who did not complete the VMRT training
  - 85% of our trained players (11/13) had ≤ 85 hits at baseline testing and 54% (7/13) had ≤ 85 hits after training
    - Only 17% of our trained players (1/6) who had > 85 hits were injured
- Reactive VMRT training improved performance and appeared to lower injury incidence, which may be explained by improved peripheral perception of environmental stimuli at a viewing angle of approximately 45 degrees (Figure 1)
- More research is needed to refine VMRT training methods for integration of central-peripheral visual input and to better understand the potential value of a simultaneous postural balance challenge for injury risk reduction

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