In collision sports such as football and rugby, muscle strength and hypertrophy are essential for player safety. Historically, strength and hypertrophy gains have been achieved with resistance training only with no BFR. Vascular occlusion or blood flow restriction (BFR) with resistance training has been hypothesized to augment increases in muscle strength and hypertrophy. However, while the potential benefits of BFR have been explored and minimized, the optimal pressure range of the occlusion during training remains unclear from the literature. This clinical benefit would benefit from research to determine this range. Finally, this CAT should be reviewed in two years to determine whether additional best evidence has been published that may change the analysis for this specific clinical question.

### Methods

**Search Strategy**

- PubMed
- PEDro Database
- CINAHL
- Sport Discus
- Additional resources obtained via review of references listed in abstracts

**Inclusion and Exclusion Criteria**

- Male only
- Male only
- Limited to humans
- Exclusion
- Non-contact sports
- Female sample

**Purpose**

To determine the effect of BFR exercises to increase strength and hypertrophy in collegiate male collision sport athletes compared to untrained exercises.

### Results

**Clinical setting**, sphygmomanometer cuffs may be utilized to assure that an individual can utilize BFR. Group 1: Standard training and BFR. Group 2: high-intensity exercise without the occlusion. Group 3: 100% of 1RM exercise combined with an occlusion pressure of 100 mmHg. Group 4: Modified training, supplemental training, and deflation during the rest periods. The subjects were 32 NCAA Division III football athletes. The athletes performed 4 sets of bench press and squat with an occlusion pressure of 100 mmHg. The following increases in isokinetic knee extension torque than that in the other two groups. The cross-sectional area of knee extensor muscles increased significantly as well, suggesting that the increase in knee extension strength was mainly caused by muscle hypertrophy. The clinical benefit of BFR could lead to greater body composition with a decrease in mechanical work production and muscle force was also improved.

**Discussion and Conclusions**

This study demonstrated that the use of a practical BFR program in combination with a traditional high-intensity off-season training program was effective in increasing 1RM squat performance in trained collegiate athletes.

The BFR could lead to greater body composition with a decrease in mechanical work production and muscle force was also improved.

**References**


**Table 1. Characteristics of Included Studies**

<table>
<thead>
<tr>
<th>Participants</th>
<th>Outcomes</th>
<th>Main Findings</th>
<th>Level of Evidence / Validity</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cook et al (2014) Case Control</td>
<td>Forty percent</td>
<td>The athletes performed 4 sets of bench press and squat with an occlusion pressure of 100 mmHg.</td>
<td>Level 1b. Validity: N/A</td>
<td>Bilateral knee extension was prevented in a seated position using an isometric leg extension machine.</td>
</tr>
<tr>
<td>Littler et al (2004) Cohort</td>
<td>Primary outcomes: Pre and post test for 1RM bench press, 1RM leg press, and girth measurements</td>
<td>Follow up univariate ANOVA indicated a significant difference for 1RM squat in the group that completed high-intensity training with BFR. No differences were noted in the other groups.</td>
<td>Level 2b. Validity: N/A</td>
<td>The clinical benefit could also be achieved with BFR.</td>
</tr>
<tr>
<td>Takarada et al (2002) Cohort</td>
<td>Secondary outcomes: Subject compliance</td>
<td>The cross-sectional area of knee extensor muscles increased significantly as well, suggesting that the increase in knee extension strength was mainly caused by muscle hypertrophy. The clinical benefit of BFR could lead to greater body composition with a decrease in mechanical work production and muscle force was also improved.</td>
<td>Level 2b. Validity: N/A</td>
<td>Based upon these findings, clinicians could select BFR to achieve a healthy athlete's resistance training plan. In addition, BFR augmentation was shown to be beneficial even when using only a limited amount of resistance. Benefits were seen as at least 20-50% of the athlete's single repetition maximal limb (1RM) for a specific activity. These findings may indicate that an individual can utilize BFR even when they are unable to train at their normal intensity due to injury or fatigue.</td>
</tr>
<tr>
<td>Yamamoto et al (2012) Cohort</td>
<td>The subjects were 32 NCAA Division III football athletes. The athletes performed 4 sets of bench press and squat with an occlusion pressure of 100 mmHg.</td>
<td>The study used a practical BFR program in combination with a traditional high-intensity off-season training program was effective in increasing 1RM squat performance in trained collegiate athletes.</td>
<td>Level 2b. Validity: N/A</td>
<td>Occlusion training could provide additional benefits to traditional strength training to improve muscular hypertrophy and muscle strength in collegiate athletes.</td>
</tr>
</tbody>
</table>

**Occlusion Training Increases Strength and Hypertrophy in Collegiate Male Sport Athletes**

Concussions are a common sports injury that have short- and long-term effects. Concussions are defined as injuries to the head resulting from blunt trauma, acceleration forces or deceleration forces with some observed signs of neurological or neuropsychological dysfunction. It has been estimated that between 2.5 million1 and 3.8 million2 concussions occur in the U.S. each year.3

While the current definition of a concussion remains controversial, it is widely accepted that concussions are a common sports injury that have short- and long-term effects. Concussions are defined as injuries to the head resulting from blunt trauma, acceleration forces or deceleration forces with some observed signs of neurological or neuropsychological dysfunction. It has been estimated that between 2.5 million1 and 3.8 million2 concussions occur in the U.S. each year.3

In athletes across 3 and long


Train

Height(cm

Pretest

Study

Ethics

Compare:

Participates

Inclusion and Exclusion Criteria

Inclusion

Limited to English

Limited to humans

Limited to within the past 10 years (2004-2014)

Exclusion: Non-sport collision

METHODS

Search Strategy:

Terms Used OR Guide Search

Patient/Client Group: Collision Sport Athletes

Intervention(s)/Assessment: Neck Strengthening Programs

Comparison: No intervention and control

Outcome(s): Head impact biomechanics

Linear head impact biomechanics

Neck strengthening OR Neck muscles OR cervical strength OR cervical strengthening OR cervical muscles OR (neck AND resistance training OR muscle strength)) AND (concussion OR concussion brain injury OR traumatic brain injury)

Evidence Sources

Search databases

PubMed @ Ovid

The Cochrane Library

PEDro Database

Proquest

Sport Discus

Additional resources obtained via review of reference lists and hand search

Inclusion and Exclusion Criteria

Inclusion

Limited to English

Limited to humans

Limited to within the past 10 years (2004-2014)

Exclusion: Non-sport collision

RESULTS

Three relevant studies4-6 were located and categorized as shown in Table 1.

One additional investigation was excluded because it offered level 4 evidence. In addition to the information in Table 1, two of the selected studies4 had a calculated effect size between .589 and .999. The effect size for the third selected study4 could not be calculated with the reported data. Instead, the authors reported a 95% confidence interval for linear acceleration ranging from .112 to .387 and rotational acceleration from .060 to .853.

In the current review, we determined that there was a 1.75 times higher odds for sustaining moderate linear head impact.4 It was noted that neck strengthening programs may be implemented to increase neck strength but that this intervention may not lead to the desired outcome of altering head impact biomechanics.15

To evaluate the effect of cervical muscle strength on biomechanical measures of head impact, Linear head acceleration, Rotational Head acceleration, Head impact telemetry severity profile.

Each strength measure was significantly different across the tertile groups (P<0.05). Significant difference in the HITsp in athletes across 3 tertiles of upper trapezius muscle strength (F2,29= 7.37; P=0.037). Athletes with the strongest (i.e. lowest) cervical muscle strength (HITsp) measured measures with athletes with moderate (14.4; 95% CI, 13.3-14.4) or low (13.6; 95% CI, 13.2-14.4) upper trapezius strength. Upper trapezius muscles with more strength (14.4; 95% CI,14.0-14.8) experienced worse (i.e. higher) compared to those with moderate (14.0; 95% CI, 13.5-14.4) or low (13.6; 95% CI, 13.2-14.4) upper trapezius strength. 3b; N/a

**Hypothesis that players with greater static neck strength would experience lower levels of cervical acceleration was not supported.** Contrasts indicate that cervical muscle strength lessens head impact acceleration.

Guskiewicz et al.14 conducted that would alter the biomechanics of head impact.15

Guskiewicz et al.14 conducted that would alter the biomechanics of head impact.15

37 youth hockey players. 2 AAA level permitted to check in competition, forward 49 Football players (34 college, 15 collegiate), Age: High school (16.6; 9.9), Collegiate (16.7; 9.9), HITsp (cm): Mean (189.4±10.5), SD (95% CI: 188.4-190.4) < 189.4 cm, Outcomes (n=18).

To evaluate the effect of cervical muscle strength on biomechanical measures of head impact, Linear head acceleration, Rotational Head acceleration, Head impact telemetry severity profile.

Each strength measure was significantly different across the tertile groups (P<0.05). Significant difference in the HITsp in athletes across 3 tertiles of upper trapezius muscle strength (F2,29= 7.37; P=0.037). Athletes with the strongest (i.e. lowest) cervical muscle strength (HITsp) measured measures with athletes with moderate (14.4; 95% CI, 13.3-14.4) or low (13.6; 95% CI, 13.2-14.4) upper trapezius strength. Upper trapezius muscles with more strength (14.4; 95% CI,14.0-14.8) experienced worse (i.e. higher) compared to those with moderate (14.0; 95% CI, 13.5-14.4) or low (13.6; 95% CI, 13.2-14.4) upper trapezius strength. 3b; N/a

**Hypothesis that players with greater static neck strength would experience lower levels of cervical acceleration was not supported.** Contrasts indicate that cervical muscle strength lessens head impact acceleration.

Linenard and colleagues14 investigated head impact biomechanics in collision sport athletes. The current research looks solely at male athletes. Research is also warranted to compare head impact biomechanics to individuals of differing age groups, and from different sports to note changes in these demographics. It would also be beneficial to investigate muscle activation intensity and timing in response to anticipated and unanticipated forces. Finally, this CAT should be reviewed in two years for further research has been conducted that would alter the outcomes.

REFERENCES


