# Neck Strength, Flexibility, Posture, and Proprioception in U.S. Army Pilots with and without a History of Neck Pain

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## 1. INTRODUCTION

- Neck pain (NP) is common among military helicopter pilots
- Previously, military helicopter pilots with a history of NP demonstrated less neck strength and flexibility when compared to pilots without a history of NP
- Other factors such as weak scapular muscles, poor head and shoulder posture have not been investigated in military helicopter pilots
- The purpose of the study was to investigate neck strength, flexibility, posture, and proprioception in pilots with and without a history of NP

## 2. METHODS

### SUBJECTS (Table 1)

- Twenty-seven male pilots with a history of NP and age-matched pilots
- Pain Characteristics (0-10 Numeric Scale: 4.0 ± 1.7, pain duration: 1.5 ± 1.7 days, and Neck Disability Index: 6.9 ± 5.6)

| | Pain Group | No-Pain Group |
|---|---|---|
| Age (years) | 34.5 ± 6.4 | 34.3 ± 6.1 |
| Height (cm) | 176.9 ± 7.1 | 177.3 ± 8.5 |
| Mass (kg) | 84.8 ± 11.2 | 83.0 ± 12.0 |
| Flight Experience (years) | 8.5 ± 6.0 | 9.0 ± 6.1 |
| Total Flight-Hour (hours) | 1800.9 ± 1460.7 | 1907.0 ± 1365.4 |
| Total NVG Fight-Hour (hours) | 446.7 ± 438.9 | 448.0 ± 426.3 |
| 12-month Flight-Hour (hours) | 216.5 ± 156.7 | 258.6 ± 188.5 |

Table 1: Demographics and Flight Characteristics

### EQUIPMENT

- Lafayette handheld dynamometer (HHD) and the Biodex System 3 PRO dynamometer (Biodex, Shirley, NY) for strength testing (Figure 1)
- CROM 3 (Performance Attainment Associates, Lindstrom, MN) for neck flexibility and forward head posture (Figure 2)
- A modified 16-inch combination square (Swanson Tool Co., Frankfort, IL) for forward shoulder posture and pectoralis minor length (Figure 3)
- Vicon Nexus motion capture system (Vicon Motion Systems, Centennial, CO) for proprioception testing (Figure 4)

### PROCEDURES

- For strength testing, after warm-up trials, pilots performed the maximal isometric contraction against HHD for neck and scapular strength and the maximal isokinetic contraction against Biodex for the upper scapular strength
- For neck flexibility testing, pilots wore CROM 3 and actively rotated neck in each direction (flexion, extension, lateral flexion, and rotation) three times
- Forward head posture was assessed in a sitting position wearing CROM 3 with a forward head attachment, and the horizontal distance from C7 and mid-ear was measured
- Forward shoulder posture was assessed in standing, and the distance from the wall to the anterior tip of the acromion process was measured
- Pectoralis minor length was assessed in a supine position, and the distance from the floor to the posterior tip of the acromion was measured
- For all postural assessments, an average of three trials were used
- For neck proprioception, pilots wore a blindfold, turned neck to target position (with guidance), and replicated the target position without guidance to evaluate joint angle differences (four target positions)
- A mean absolute joint errors for five trials were used for analyses

Fig 1: Neck and Scapular Strength Testing

Fig 2: Neck Flexibility and Forward Head Posture

Fig 3: Fwd Shld Posture

Fig 4: Proprioception

### DEPENDENT VARIABLES

- Strength was measured in peak force normalized in body mass (%BM) for neck flexion, extension, lateral flexion, rotation, upper trapezius, middle trapezius, and lower trapezius
- Flexibility was measured in degrees (°) for neck flexion, extension, lateral flexion, and rotation for flexibility
- Posture was measured in centimeters (cm) for forward head posture, forward shoulder posture, and pectoralis minor length
- Proprioception was measured in degrees (°) for each target position (R30, R60, L30, and L60)

### STATISTICAL ANALYSIS

- Each variable was screened for outliers and normality
- Paired t-tests or Wilcoxon tests were used to compare all variables between groups (p<0.05)

## 3. RESULTS

- No significant differences on neck and scapular strength (Table 2)
- Pilots with a history of NP had significantly less neck flexibility on extension and rotation directions (p<0.05) (Table 3)
- No significant differences on forward head and shoulder posture and pectoralis minor length (Table 3)
- No significant differences on neck proprioception (Table 4)

| Strength (%BM) | Pain Group | No-Pain Group | p |
|---|---|---|---|
| Flexion | 17.6 ± 3.5 | 17.5 ± 3.9 | 0.904 |
| Extension | 31.3 ± 5.2 | 32.3 ± 4.9 | 0.518 |
| Lateral Flexion R | 25.2 ± 3.5 | 26.9 ± 5.0 | 0.154 |
| Lateral Flexion L | 26.1 ± 3.8 | 28.2 ± 6.0 | 0.152 |
| Rotation R | 20.3 ± 3.7 | 21.2 ± 4.0 | 0.366 |
| Rotation L | 20.7 ± 3.6 | 22.3 ± 4.9 | 0.241 |
| Upp. Trapezius R | 503.1 ± 111.7 | 533.4 ± 105.9 | 0.363 |
| Upp. Trapezius L | 538.9 ± 131.4 | 576.9 ± 109.8 | 0.279 |
| Mid. Trapezius R | 13.2 ± 4.1 | 14.4 ± 3.6 | 0.195 |
| Mid. Trapezius L | 12.7 ± 3.5 | 13.5 ± 3.3 | 0.385 |
| Low. Trapezius R | 13.8 ± 3.9 | 15.2 ± 4.0 | 0.160 |
| Low. Trapezius L | 13.5 ± 3.9 | 14.7 ± 3.8 | 0.297 |

Table 2: Neck and Scapular Strength

| Flexibility (°) / Posture (cm) | Pain Group | No-Pain Group | p |
|---|---|---|---|
| Flexion | 56.1 ± 9.9 | 59.1 ± 8.3 | 0.271 |
| Extension | 63.7 ± 8.5 | 68.3 ± 7.4 | 0.048* |
| Lateral Flexion R | 48.4 ± 6.7 | 52.4 ± 9.7 | 0.054 |
| Lateral Flexion L | 49.8 ± 8.3 | 54.3 ± 8.6 | 0.051 |
| Rotation R | 67.7 ± 8.8 | 73.4 ± 7.4 | 0.034* |
| Rotation L | 67.4 ± 9.0 | 72.9 ± 6.8 | 0.030* |
| Forward Head Posture | 22.1 ± 1.5 | 21.7 ± 1.6 | 0.201 |
| Forward Shld Post. R | 16.8 ± 2.0 | 16.4 ± 1.9 | 0.437 |
| Forward Shld Post. L | 16.7 ± 2.4 | 15.7 ± 2.0 | 0.079 |
| Pec. Minor Length R | 7.1 ± 1.7 | 7.3 ± 1.5 | 0.819 |
| Pec. Minor Length L | 6.5 ± 1.4 | 6.6 ± 1.4 | 0.726 |

Table 3: Neck Flexibility and Posture (* represents sig. group diff.)

| Proprioception (°) | Pain Group | No-Pain Group | p |
|---|---|---|---|
| Abs. Error at R30 | 3.2 ± 1.6 | 3.2 ± 1.8 | 0.857 |
| Abs. Error at R60 | 2.0 ± 1.2 | 2.2 ± 1.3 | 0.334 |
| Abs. Error at L30 | 3.2 ± 1.7 | 3.0 ± 1.4 | 0.600 |
| Abs. Error at L60 | 1.9 ± 0.7 | 2.2 ± 1.3 | 0.946 |

Table 4: Neck Proprioception

## 4. CONCLUSION

- The results demonstrate suboptimal neck flexibility in pilots with a history of neck pain
- Operating a helicopter with limited neck flexibility or neck pain may negatively impact flight safety and force readiness
- It is important to assess neck flexibility routinely and address limitation with stretching exercise

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