Issue Rehabil. Orthop. Neurophysiol. Sport Promot. 2020; 30: 40–47. ISSN 2300-0767
DOI: 10.19271/IRONS-000110-2020-30

RESEARCH REPORT

CARPAL TUNNEL SYNDROME IN BULLSEYE SHOOTERS. RESULTS OF PRELIMINARY CLINICAL SCREENING

ZESPÓŁ CIEŚNI KANAŁU NADGARSTKA U STRZELCÓW SPORTOWYCH. WYNIKI WSTĘPNEGO BADANIA PRZESIEWOWEGO

Aleksander Rajczewski, Michał Kaźmierczak, Artur Fabijański, Ksawery Bogusławski
Department of Pathophysiology of Locomotors Organs, University of Medical Sciences, Poznan, Poland

ABSTRACT

Introduction

Bullseye shooting belongs to disciplines of shooting sports which are trained with firearms. Shooting sports might be associated with neuropathies in the extremity used while shooting, including carpal tunnel syndrome (CTS), which is a relatively common medical condition. It is a result of pathological processes in the carpal tunnel causing compression and traction of the median nerve which may occur due recoil and maintaining shooting position.

Aim

This research was conducted using common clinical studies of evaluation to examine whether people training bullseye shooting with handguns are at greater risk of developing CTS in comparison with general population.

Material and methods

Shooters' anthropometric data was gathered. Screening based on following criteria was conducted: 1) being an active member of shooters club for at least 6 months, 2) not meeting exclusion criteria. The clinical studies included three tests: 1) Tinel-Hoffman sign from median nerve, 2) impairment of sensory perception in von Frey filaments test, 3) history of characteristic CTS symptoms. At least one positive outcome out of three tests suggested being positively screened for possible CTS. Additionally Froment sign was tested.

Results

We conducted a screening test on 42 shooters, 10 patients were tested positively on CTS symptoms in the shooting hand. Froment sign was found in 2 patients.

Conclusions

The result to emerge from the collected data is that bullseye shooters have higher prevalence of highly possible CTS than the rest of the population – 23.8% vs 3.8 to 14.4% of general population. This was only a pilot study and it needs continuation using neurophysiological examination.

Keywords: Carpal Tunnel Syndrome, bullseye shooting, short firearm, screening, Tinnel-Hoffman sign, von Frey's filaments

Author responsible for correspondence:
Aleksander Rajczewski
Department of Pathophysiology of Locomotor Organs
University of Medical Sciences
28 Czerwca 1956 No 135/147
61-545 Poznań, Poland
aleksander.rajczewski@gmail.com

Authors reported no source of funding
Authors declared no conflict of interest

Date received: 13th March 2020
Date accepted: 9th April 2020

STRESZCZENIE

Wstęp

Strzelectwo sportowe należy do sportów trenowanych przy użyciu broni palnej. Grupa dyscyplin sportów strzeleckich może mieć wpływ na powstawanie neuropatii w używanej kończynie, włączając w to zespół cieśni nadgarstka (CTS), który jest relatywnie częstym zespołem z ucisku. Wywołują go procesy patologiczne zachodzące w cieśni nadgarstka powodując ucisk i stan zapalny nerwu pośrodkowego, które mogą być spowodowane odrzutem broni i utrzymywaniem pozycji strzeleckiej.

Cel

Badanie przeprowadzono z użyciem powszechnych sposobów oceny klinicznej, aby sprawdzić, czy ludzie trenujący strzelectwo sportowe używając krótkiej broni palnej są w grupie ryzyka rozwoju CTS w porównaniu z resztą populacji.

Materiał i metody

Zebrano dane antropometryczne strzelców i przeprowadzono badanie przesiewowe oparte na następujących kryteriach: 1) bycie aktywnym członkiem klubu strzeleckiego przez co najmniej 6 miesięcy, 2) nie spełnienie kryteriów wykluczenia. Kliniczna część badań zakładała trzy testy: 1) objaw Tinnela-Hoffmana z nerwu pośrodkowego, 2) uszkodzenie percepcji sensorycznej w teście filamentami von Freya, 3) historia charakterystycznych objawów CTS u badanego. Przynajmniej jeden pozytywny wynik w trzech testach sugerował CTS. Dodatkowo zbadano objaw Fromenta.

Wyniki

Badanie przesiewowe przeprowadzono na 42 strzelcach, z których 10 uzyskało pozytywny wynik w kierunku symptomów CTS w ręce strzelającej. Objaw Fromenta był dodatni u 2 pacjentów.

Wnioski

Wyniki, które uzyskano pozwalają na stwierdzenie, że istnieje większe prawdopodobieństwo wystąpienia CTS u strzelców sportowych niż u reszty populacji – 23.8% w stosunku do przedziału od 3.8 do 14.4%. To badanie było jedynie pilotażem i potrzebne jest zgłębienie tematyki z wykorzystaniem badań neurofizjologicznych.

Słowa kluczowe: zespół kanału nadgarstka, strzelectwo sportowe, krótka broń palna, objaw Tinela-Hoffmana, filamenty von Frey'a

Introduction

Bullseye shooting belongs to disciplines of shooting sports which are trained with firearms. Sportsmen score points by slow and precise shooting to a target that is round in shape; the closer to the center the more points one earns. People involved are at risk of many injuries, most commonly: muscle tears, strain, tendinitis, and sprain, localized in hand, wrist and shoulder, but also in lower extremity (Kabak *et al.,* 2016). Study has shown, that 28% of examined shooters presented with at least ten lower back pain lifetime incidents, which is the same occurrence as in the group of weight lifters, and significantly higher than 7% in the group of long distance runners (Räty *et al.,* 1997). Shooting sports might be associated with neuropathies in the limb extremity used to shoot; there are following examples of such conditions: 1) carpal tunnel syndrome (CTS),

2) brachial plexus neuropathy, 3) cervical and thoracic spinal osteoarthritis, 4) spinal disc herniation and compression of nerve root. Currently, the body of literature does not present results of clinical studies on this issue.

CTS is a relatively common medical condition, estimated by some studies to extend as far as 7.8% of US population (Dale *et al.,* 2013) Its pathophysiology includes increased pressure in the carpal tunnel, decreased median nerve microcirculation, connective tissue and nerve sheath alterations and synovial tissue hypertrophy, causing compression and traction of the median nerve (Aboonq, 2015). Early symptoms include pain, numbness and tingling of thumb, index, middle finger and radial half of the ring finger while late symptoms present as weakening and atrophy of thenar muscle (Aroori and Spence, 2008).

The etiology of CTS is diverse; it can occur due to many local, regional and systemic medical conditions such as trauma, tumors, anatomical abnormalities, rheumatoid arthritis, amyloidosis, diabetes, obesity, pregnancy, hypothyroidism (Aroori and Spence 2008). Additionally, genetic background is proposed to be the especially strong component affecting development of CTS (Hakim *et al.,* 2002); although the cited research was focused only on female population it is reasonable to assume significant liability to CTS due to hereditary risk factors also in male population. Moreover, since shooting is similar to manual labours, it is believed that potential risk factors of CTS associated with the mentioned type of sport may be similar as well. The higher prevalence of CTS in population engaged in this type of work – especially on involvement of: repetitive movement, force application, vibration and holding wrist posture (vibration and holding wrist posture – being of lesser importance) (Kozak *et al.* 2015) might be congruent to shooting population; these elements of manual labour are also a part of shooting routine: repeated movements of index finger pulling the trigger, application of force to counter the recoil and maintaining static wrist posture while aiming. Unable to find any study examining this area, we decided to determine whether bullseye shooting is associated with increased risk of CTS. A discovery of correlation, could be of significance for marksmen population health: awareness of the risk may be a valid reason to conduct screening tests that would lead to earlier diagnosis of CTS and thus prevention of severe complications impacting shooting abilities and quality of life. Choosing the right target group was essential, hence we examined volunteers – members of local shooter's sport club who mainly use guns – short firearms.

Aim

We conducted this research to examine whether people training bullseye shooting with handguns are at greater risk of developing CTS in comparison with general population, using common clinical studies of evaluation.

Material and methods

Screening consisting of 3 subtests was conducted on patients who: 1) met following inclusion criteria: being an active member of shooters club, who had been training regularly with a handgun for at least 6 months and signed written informed consent; 2) did not meet exclusion criteria: recent pregnancy, sustained severe spinal or head injury, present pacemaker or cochlear implant, with history of stroke and other mild neurological and autoimmune diseases.

The Bioethics Committee of Poznan University of Medical Sciences approved the study (decision number 696/18 of 14 June 2018). All procedures were performed in accordance with the Declaration of Helsinki.

The clinical studies included three tests: 1) Evaluation of Tinel-Hoffman sign from median nerve (Lifchez *et al.,* 2010) stimulated proximal to carpal tunnel; 2) impairment of sensory perception in von Frey filaments test (vFf) (Lisiński and Huber, 2017); filaments were applied on fingertips on palm side of fingers supplied by the branch of the median nerve travelling through carpal tunnel. Three diameter sizes of filaments were used and every patient was examined with all of them. The minimal diameter of the filament, which was still noticeable by patient, determined an outcome of the test. Patient's confirmation of touch by filament of 0.30 mm in diameter corresponded to normal perception, diameter of 0.12 mm was associated with hyperesthesia and 0.55 mm with analgesia; 3) a history of characteristic symptoms of CTS reported by a patient; especially incidence of pain or numbness from the region innervated by the part of median nerve contained in the carpal tunnel and nocturnal awakening with tingling or numbness.

Additionally, Froment sign towards ulnar neuropathy at wrist (Christopher *et al.*, 2016) was tested since it can coexist with CTS.

Moreover, we collected data about shooters' anthropometric properties: sex, age, height, weight and details concerning training: frequency of trainings, years of practice.

Results

We conducted screening test on 42 shooters (5 women and 37 men); 13 patients were tested positively on CTS symptoms: 1) 12 positive Tinel-Hoffman signs (3 non-shooting hands), 2) 1 hypoesthesia detected by vFf (both hands), 3) 5 positive interviews (4 concerning shooting hands and 1 non-shooting).

After exclusion of shooters with symptoms which were not present in the shooting hand, the number of positively screened was equal to 10 (3 women and 7 men) (Figure 1). Tinnel-Hoffman sign was positive in 9 patients: it was the only symptom in 6 cases, 2 suffered in addition from history of characteristic symptoms of CTS, while 1 was found to additionally have hypoesthesia and history of characteristic symptoms of CTS. There was 1 patient who was tested positively only due to history of characteristic symptoms. Interestingly, vFf revealed 36 patients with hyperesthesia and 5 with normal sensory function in regard to shooting hand.

Froment sign was present in 2 patients: in one negatively screened (shooting hand was affected) and in one positively enrolled who suffered only from history of characteristic symptoms of CTS. Interestingly he used both his hands to shoot and one hand was affected by possible CTS while the second displayed positive Froment sign.

Anthropometric properties of 10 positively screened sportsmen differed from the ones with negative symptoms in both hands. These shooters were younger; their age on average was 44 years which meant that there was 11 year difference between healthy sportspeople (negatively screened were on average 55 years old). Obesity was also lower on average in this group: 27.41 vs 28.55. Furthermore, we found that they train on average less often (3.5 vs 7.7 per month). Additionally, they had less experience in shooting – they shot for shorter period of time (9.8 vs 13.4 years) (Figure 2).

Discussion

The incidence of Froment's sign among shooters was insignificant; in total 2 shooters were found: one in the group which was screened positively for CTS and one in the negatively screened group. The single most interesting result to emerge from the data collected is that bullseye shooters have higher prevalence of highly possible CTS than the rest of the population – 23.8% (10 positively screened out of 42) vs 14.4% of general population (Atroshi *et al.* 1999). The mentioned percentage of people refer to those who reported suffering from numbness/tingling and pain in the median nerve distribution in the survey; however if clinical examination was applied they detected CTS in only 3.8% of general population. These numbers were cited in comparison as they represent a methodology which is the most similar to the screening we conducted; they show a part of given population with clinical findings without results from nerve conduction studies. Due to the fact that the mentioned paper focused only on Swedish population, for more accurate comparison, a similar study performed on Polish population should be conducted. Interestingly, we found more shooting women

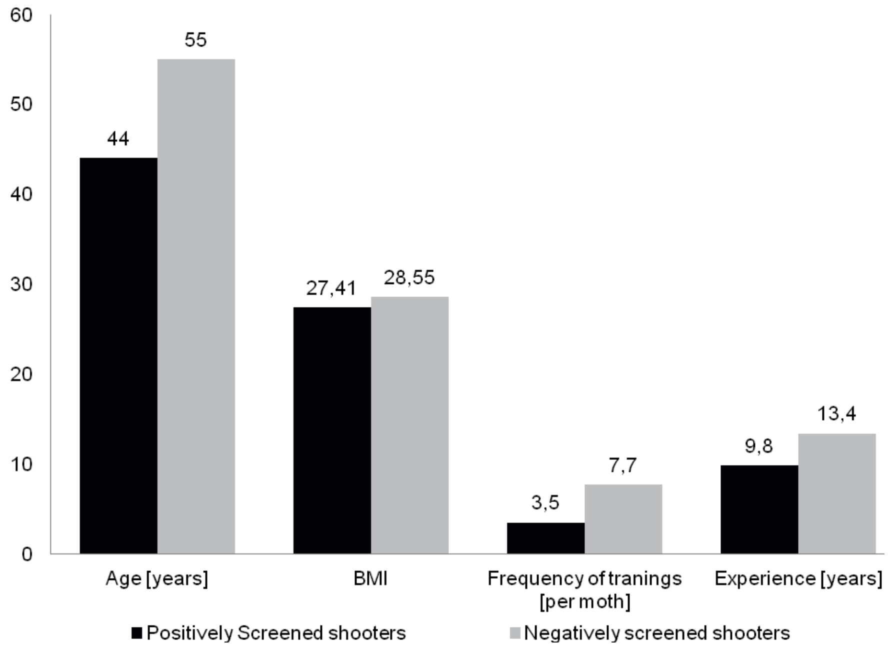

Figure 1. Number of positively screened shooters (10 out of 42) displaying specific symptoms on screening tests.

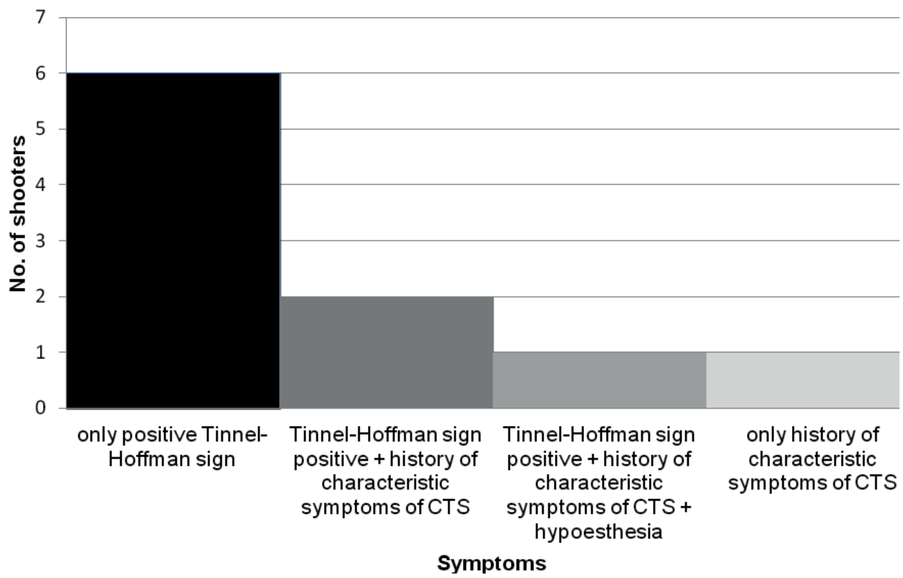

Figure 2. Graphical presentation of anthropometric properties of shooters (age and BMI) and details concerning training (frequency of trainings and experience).

than man that were positively screened for CTS (60% vs 18.9%), however due to a substantially smaller group of examined females we cannot reliably compare results of two sexes. Most importantly our findings comply with initial hypothesis: bullseye shooting with a handgun may be a significant risk factor of developing CTS. It would be in line with this sport being an activity which involves biomechanical factors that are believed to be associated with risk of CTS: hand-arm vibration, prolonged work with flexed or extended wrist, high repetitiveness and their combination (van Rijn *et al.* 2009; Kozak *et al.* 2015).

Analyzing differences between those positively screened and those who did not require careful interpretation. The first group consisted of shooters who were on average younger (44 vs 55 years old), less obese (BMI equal to 27.41 vs 28.55), moreover they shot less often (3.5 vs 7.7 per month) and for shorter period of time (9.8 vs 13.4 years); these results are peculiar as exposure to shooting in a positively enrolled group was lower. It might imply involvement of other factors in development of CTS such as mentioned before genetic liability (Hakim *et al.* 2002) or lifestyle dissimilarities associated with differences in age between two groups. These factors combined with shooting could have achieved synergistic impact on development of CTS. To attain greater clarity, projects of future studies should take into consideration possible impact of other factors. This study should be interpreted as a preliminary insight into the examined matter.

Furthermore, we are aware that this paper may exhibit several limitations. The first is the fact that our results are derived from screening tests and each of them has limited sensitivity and specificity. Tinel's sign test according to recent studies is characterized by sensitivity of 37.7% or 89% and specificity of 41% or 90% (Hegmann *et al.* 2018; Küçükakkaş O *et al.* 2019), history of characteristic symptoms of CTS displays 11.3–77.4% and 79.6–97.5% respectively (Hegmann *et al.* 2018) or 93% and 46% in different studies (Küçükakkaş *et al.* 2019). Von Frey filaments test displays sensitivity of 52% (Borg K *et al.* 1988) and due to lack of data on its specificity we speculate that it might be similar to that of two-point discrimination test being equal to 85% (Küçükakkaş *et al.* 2019). However, applying three separate tests at the same time as it was done is highly likely to substantially magnify sensitivity and specificity and as a method is certainly more plausible than survey responses which were used to estimate CTS prevalence in the referenced study from Sweden (Atroshi *et al.* 1999). Therefore, our results consist in comparison presumably of much less false positives outcomes. Ultimately, they found that only 3.8% of general population suffer from clinically certain and 2.7% from clinically and neurophysiologically certain CTS. The methodology we applied is not sufficient to confirm a clinically certain CTS. In order to decisively diagnose patients with CTS, neurophysiological tests must be performed, for they show high specificity of 83–100% (Lew *et al.* 2005) – future studies on this issue should include them in methodology.

The second is that our investigation has been so far performed only on a small scale as preliminary study with purpose to verify whether conducting extended research is valid. Our group consisted of only 42 shooters and the heterogeneity of the group is high – their anthropometric characteristics differ. Interestingly, positively screened shooters were on average younger, which could have meant involvement of different risk factors of CTS apart from shooting due to, for example, mentioned lifestyle dissimilarities or genetic background.

The third is the fact, that shooters used firearms with different calibers, weight and types of ammunition: rimfire and centerfire. These factors impact force that is directed into the hand on shot which may affect development of CTS. Furthermore, there is a wide variety of handles and since they determine ergonomics of a weapon, it is safe to assume that it might have been of a significance in pathology CTS.

The fourth limitation of our study is the fact that it was focused on sportsmen using mainly handguns and so our results are not fully applicable to population using long guns as in their case a significant part of recoil force is transferred additionally (apart from the hand and wrist) into the shoulder, thus double crush syndrome may occur and affect development of CTS and other neuropathies. It might be beneficial to examine CTS prevalence in populations of shooters that differ in regard to type of weapons and ammunition they use. It is likely to provide data necessary to conclude which category of weapon (short vs long) is associated with the least significant risk of developing CTS, additionally similar data about other neuropathies may be acquired.

Conclusions

Bullseye shooting trained with short firearm was found to be highly likely associated with an increased risk of developing CTS in a shooting hand. Due to scarce population and its heterogeneity in our study further research is required to establish accurate correlation between parameters of weapon, training and prevalence of CTS. We believe that large, multicenter study supplied additionally with nerve conduction studies on homogeneous population in regard to anthropometric properties and details concerning training would lead to greater understanding of CTS risk in this sport. Our study is, to our knowledge, the first to undertake the problem of CTS in shooting population. There are millions of bullseye shooters around the world and our findings may lead to greater awareness of CTS risk and thus earlier diagnosis which would correspond to prevention of severe complications impacting shooting abilities and quality of life.

REFERENCES

Borg K, Lindblom U. (1988) *'Diagnostic value of quantitative sensory testing (QST) in carpal tunnel syndrome.'* Acta Neurol Scand., 78 (6), pp. 537–41.

Christopher J. Dy, Susan E. Mackinnoncorresponding author. (2016) *'Ulnar neuropathy: evaluation and management.'* Curr Rev Musculoskelet Med., 9(2), pp. 178–184.

Dale AM, Harris-Adamson C, Rempel D, Gerr F, Hegmann K, Silverstein B, Burt S, Garg A, Kapellusch J, Merlino L, Thiese MS, Eisen EA, Evanoff B. (2013) *'Prevalence and incidence of carpal tunnel syndrome in US working populations: pooled analysis of six prospective studies.'* Scand J Work Environ Health, 39 (5), pp. 495–505.

Hakim AJ, Cherkas L, El Zayat S, MacGregor AJ, Spector TD (2002) *'The genetic contribution to carpal tunnel syndrome in women: a twin study.'* Arthritis Rheum., 47 (3), pp. 275–9.

Hegmann KT, Merryweather A, Thiese MS, Kendall R, Garg A, Kapellusch J, Foster J, Drury D, Wood EM, Melhorn JM. (2018) *'Median Nerve Symptoms, Signs, and Electrodiagnostic Abnormalities Among Working Adults.'* J Am Acad Orthop Surg., 26 (16) pp. 576–584.

Kabak B, Karanfilci M, Ersöz T, Kabak M. (2016) *'Analysis of sports injuries related with shooting.'* J Sports Med Phys Fitness., 56 (6), pp. 737–43.

Kozak A, Schedlbauer G, Wirth T, Euler U, Westermann C, Nienhaus A. (2015) *'Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: an overview of systematic reviews and a meta-analysis of current research.'* BMC Musculoskelet Disord., 16:231.

Küçükakkaş O, Yurdakul OV. (2019) *'The diagnostic value of clinical examinations when diagnosing carpal tunnel syndrome assisted by nerve conduction studies.'* J Clin Neurosci., 61, pp. 136–141.

Lew, H. L., Date, E. S., Pan, S. S., Wu, P., Ware, P. F., & Kingery, W. S. (2005) *'Sensitivity, specificity, and variability of nerve conduction velocity measurements in carpal tunnel syndrome.'* Archives of Physical Medicine and Rehabilitation, 86 (1), pp. 12–16.

Lifchez SD, Means KR Jr, Dunn RE, Williams EH, Dellon AL. (2010) *'Intra- and inter-examiner variability in performing Tinel's test.'* J Hand Surg Am. 35 (2), pp. 212–216.

Lisiński P, Huber J. (2017) *'Evolution of Muscles Dysfunction From Myofascial Pain Syndrome Through Cervical Disc-Root Conflict to Degenerative Spine Disease.'* Spine (Phila Pa 1976), 42 (3), pp. 151–159.

Räty, H., Kujala, U., Videman, T., Impivaara, O., Battié, M., & Sarna, S. (1997) *'Lifetime Musculoskeletal Symptoms and Injuries among Former Elite Male Athletes.'* International Journal of Sports Medicine, 18 (08), pp. 625–632.

van Rijn RM, Huisstede BM, Koes BW, Burdorf A. (2009) *'Associations between work-related factors and the carpal tunnel syndrome-a systematic review.'* Scand J Work Environ Health, 35 (1), pp. 19–36.