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Carpal tunnel syndrome among milking parlor workers in Northern Italy: a comparison of screening approaches

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Parole chiave: Polso; sovraccarico biomeccanico; sindrome del tunnel carpale

Summary

Background: *Occupational tasks characterized by repetitive, awkward and forceful movements of the hand and wrist may heighten the risk of carpal tunnel syndrome (CTS) among dairy parlor workers. Median nerve impairment can be investigated with ultrasonography (US) and nerve conduction studies (NCS) but a structured questionnaire may help identify early symptoms.* **Objectives:** *Our objectives were to: a) compare the sensitivity of US investigations and NCS to detect early signs of CTS; b) explore the correlation of the results of these two tests with CTS symptoms obtained from the administration of a targeted questionnaire.* **Methods:** *Forty male milking parlor workers were recruited. The study protocol included: 1) the identification of characteristic CTS symptoms through a targeted questionnaire; 2) US imaging of the carpal tunnel inlet (using a portable ultrasound device; 3) NCS of the distal median nerve.* **Results:** *The symptom questionnaire was considered positive if at least one CTS symptom was present within two weeks prior to the examination. The symptom questionnaire showed a high level of specificity (92,6%) and sensitivity (61%) when compared with NCS results. Ultrasound results revealed a prevalence of median neuropathy of 55%, but when compared to NCS, the ultrasound showed quite low predictive values (NPV of 37% and PPV of 38%).* **Discussion:** *The symptom questionnaire was associated with the median nerve pathology often seen in CTS. Moreover, the study results have shown the questionnaire to be the most effective screening method when compared to ultrasound.*

Riassunto

«La sindrome del tunnel carpale nei mungitori: confronto fra metodi di screening in un campione di lavoratori italiani». **Introduzione:** *Gli addetti alle sale di mungitura potrebbero essere esposti a un alto rischio di sviluppo di sindrome del tunnel carpale, a causa di attività ripetitive posture incongrue e sforzi richiesti a livello del distretto mano-polso. La patologia del nervo mediano può essere indagata con l'ecografia muscoloscheletrica e gli studi di conduzione del nervo. Tuttavia un questionario potrebbe aiutare a identificare eventuali sintomi precoci.* **Obiettivi:** *Confrontare la sensibilità dell'ecografia con lo studio di conduzione nervosa per identificare segni precoci di sindrome*

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del tunnel carpale; analizzare la correlazione tra i risultati di questi due test con gli esiti di un questionario predisposto ad hoc. **Metodi:** *Lo studio è stato è stato condotto su un campione di 40 mungitori in Lombardia. Il protocollo includeva: 1) la somministrazione di un questionario sui sintomi relativi alla sindrome del tunnel carpale; 2) l'esecuzione di un'ecografia a livello del tunnel carpale (utilizzando un ecografo portatile); 3) l'esecuzione di uno studio di conduzione del nervo mediano distale.* **Risultati:** *Il questionario è stato considerato positivo in presenza di uno o più sintomi entro due settimane dalla somministrazione. Il questionario ha mostrato un'alta specificità (92,6%) e sensibilità (61%) quando confrontato con lo studio di conduzione del nervo. I risultati dell'ecografia hanno mostrato una prevalenza di neuropatia del mediano in 55% dei lavoratori, ma in confronto con lo studio di conduzione del nervo, l'ecografia ha mostrato bassi valori di predittività (VPN pari al 37% e VPP uguale a 38%).* **Discussione:** *Il questionario utilizzato è risultato predittivo di stati iniziali della sindrome del tunnel carpale. Inoltre, i risultati dello studio hanno mostrato che lo stesso rappresenta il metodo di screening più efficace della ecografia.*

Introduction

Occupational musculoskeletal diseases (MSD) are increasing throughout the world, leading to a growing need of tools adequate to perform health surveillance of the workers exposed to biomechanical risk and able to indicate the need of primary and secondary preventive actions. For this reason, the ideal tool should be able to detect early changes, be easily transported and used at the workplace and have acceptable levels of sensitivity and specificity for the disease/s of interest.

Agriculture is one of the highest risk sectors for biomechanical overload and risk for MSDs. Among the farming sectors, dairy operations represent a priority for intervention due to significant exposure in terms of hand and wrist repetitive motions (4), forearm pronation/supination, milking unit lifting (21), wrist dorsiflexion and radial deviation (20), with a significant increase of the risk of carpal tunnel syndrome (CTS). The following four milking tasks require an intensive and repetitive effort of the wrist while in awkward postures: 1) pre-dipping of the teats, which consists in disinfecting or cleaning each teat before milking; 2) wiping and stripping phases, that are often performed simultaneously; 3) attaching of the milking cluster, which involves repetitive pronation-supination of the wrist; 4) post-dipping of the teats, which consists in a final disinfection of the teat (16).

The literature suggests that the prevalence of CTS is significantly higher among workers performing milking tasks than among those performing work tasks in other areas of dairy farming (17, 18). Thus, the median nerve might be the most sensitive anatomical structure in regards to biomechanical risk present during milking parlor work activities (7, 22,). However, the body of data available is inadequate to draw firm conclusions. Despite the fact that milking parlor tasks represent very demanding physical activity (13), this agricultural sector is under-investigated.

The diagnosis of median nerve impairment is currently based on the clinical examination and supported by median nerve sensory conduction studies (NCS), which confirms the clinical diagnosis of CTS with a high degree of sensitivity (>85%) and specificity (95%) (1). This approach has been conducted with good results in the dairy industry by Patil et al. (17) and Rosecrance et al. (19). However, screening workers with nerve conduction studies is not feasible on a large scale (6) and a need exists for novel screening tools used in the routine occupational health surveillance of dairy workers conducted at the workplace (11, 16).

Ultrasonography (US) has also recently been found to be useful for CTS diagnosis (9, 23). Patients affected by CTS demonstrated ultrasonographic evidence of focal enlargement of the median nerve at the wrist. Moreover, US approaches can also identify structural changes suggesting mononeuropathy, often not detectable by electrodiagnostic studies alone (5).

With a different approach, based on a modified version of the Standard Nordic Questionnaire (14) to determine the prevalence of painful musculoskeletal

symptom in the shoulders, hands/wrist, and low back, Kolstrup (13) studied workers engaged in Swedish small-herd dairies using a picture of the body sites to describe location of perceived symptoms. While the study considered broad categories of musculoskeletal symptoms rather than specific disorders and no diagnosis of CTS was made, the results demonstrated a high prevalence of hand/wrist symptoms in both male (21%) and female (61%) workers. In 1990, Katz et al. (12) approached the problem of CTS screening using a hand symptom diagram, in which a visual representation of the hand was used to locate the symptoms. Their test, when compared to NCS used as the gold standard, showed an 80% sensitivity and a 90% specificity. In the following years, many other studies adopted the same approach: Kalaca et al. (11) focused on a large sample of workers from different industrial sectors (clothing and shoe industry, assembly industry, textile, food and metal industry) and found the proportion of symptomatic workers at 36%; Franzblau et al. (8) compared the hand symptom diagram with the NCS on over four hundred industry and tertiary sector workers and found a specificity of 84% and a sensitivity of 34%; Bonauto et al. (3) did the same comparison on 733 subjects, finding the hand symptom diagram's specificity at 87% and its sensitivity at 28%. Thus, the literature substantiates the need of developing simple screening tools able to support the occupational physician in the health surveillance at the workplace. Therefore, the present study was carried out with the aims of: a) evaluating the possible use of ultrasound as a screening tool for median nerve impairment, comparing its specificity to electrophysiologic studies for median neuropathy; b) comparing the specificity of these two tests with a symptom questionnaire to be evaluated as a possible screening tool.

Methods

The study involved 40 male dairy parlor workers employed in 21 dairy farms in Lombardy region (Northern Italy). The twenty-one farms involved in the study were representative of the milking parlor systems adopted in the Lombardy region: herringbone (13 systems, 22 workers), parallel (5 systems, 8 workers) and rotary (3 systems, 10 workers).

Before the beginning of the study procedures, both employers and employees were informed of the study purpose and methods through specifically targeted meetings. All study methods and aims were approved by the Ethical Committee of our hospital. All participants signed informed consent at the time of participation. Selection criteria included a minimum of three years of experience as dairy parlor worker and no musculoskeletal surgery or upper limb related diagnoses within the last three years.

The study protocol included: 1) identification of characteristic CTS symptoms through the administration of a questionnaire; 2) ultrasonography (US) imaging of the carpal tunnel inlet (portable ultrasound device) 3) nerve conduction studies (NCS) of the distal median and ulnar nerves.

The questionnaire (figure 1) administered by the researchers was composed of two sections: 1) demographic, personal and work experience, and 2) questions regarding location and degree of symptoms. Since most of the milking parlor workers were migrants, the symptoms section of the questionnaire was completed with a hand symptom diagram, in which the workers were asked to indicate the areas where symptoms such as tingling/numbness, burning, weakness, and pain were present (8, 12). Workers were also asked to specify the severity of their symptoms on a Visual Analogic Scale from minimum of 0 (absence) to a maximum (severe) of 10. The questionnaire was used to collect information regarding the duration of symptoms, characteristics of symptoms (constant vs intermittent and in this second case time of onset), and symptom's functional impact on work ability, if any. We considered positives for CTS those workers who reported the presence of at least one of the four symptoms evaluated in the last two weeks before the examination, in the first three fingers of the hand.

A trained sonographer performed the US examinations at the dairy with portable instrumentation (Venue Scan, Venue 40, GE Healthcare®) according to the European Society of Musculoskeletal Radiology's criteria (15) (figure 2). The investigation consisted in the collection of a static image of the carpal tunnel on both wrists, at the level of the semilunar bone in transverse plane, measuring the cross-sectional area of the median nerve (figure 3). For the

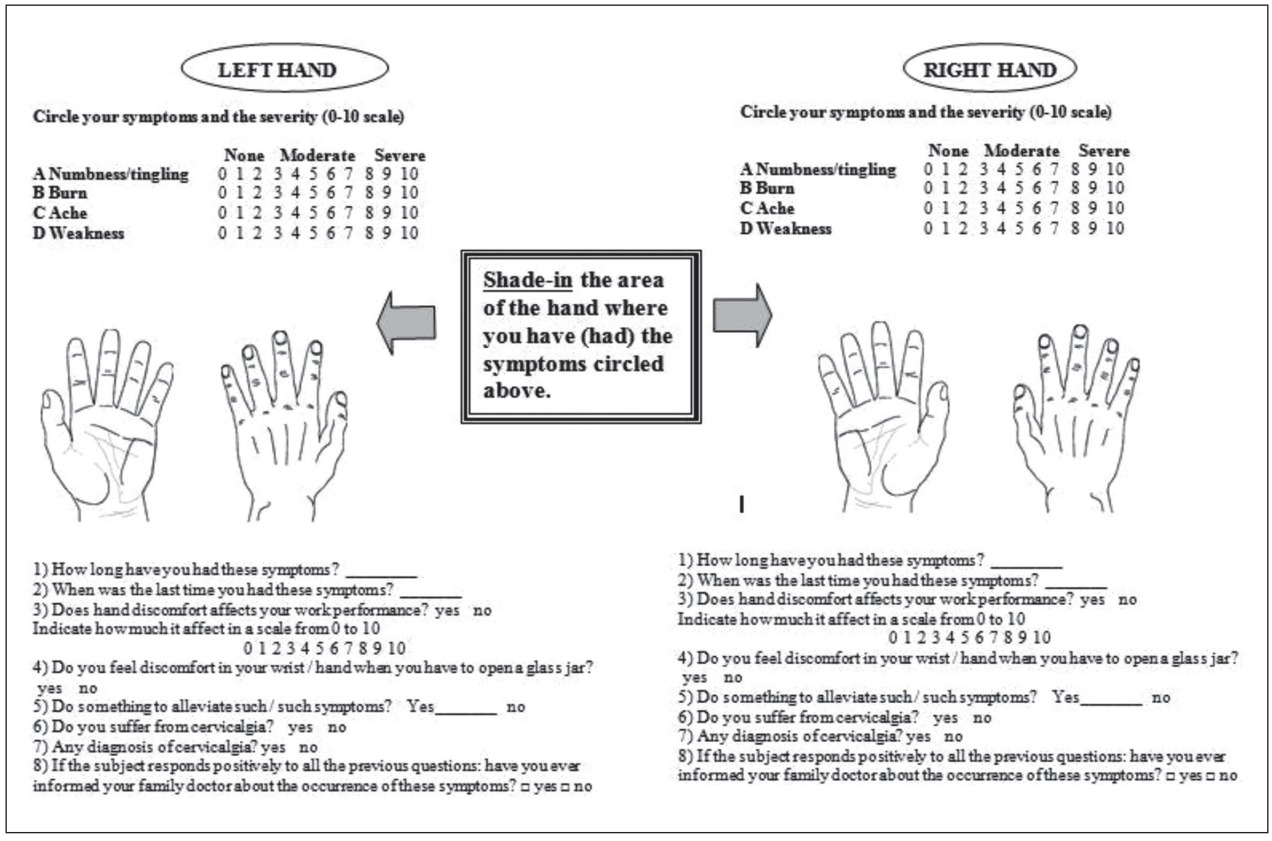

Figure 1 - The symptoms questionnaire

Figure 2 - Execution of the wrist ultrasound exam

classification of static imaging, we identified, based on the median nerve's cross sectional area, the following 2 classes: "normal" if the area was less than 10 mm^2, "pathology" if it was over 10 mm^2 (2, 24, 25).

The NCS were performed on both hands of each participant by a physical therapist blinded to the US results, worker's symptoms and history. Sensory conduction tests consisted of 14 cm antidromic median and ulnar sensory conduction latencies from the proximal wrist crease to the index and 5th fingers, respectively. If median latencies were not present, 8 cm orthodromic motor latencies were obtained from the distal wrist crease to the abductor pollicis brevis (figure 4). Median mononeuropathy was defined as a median-ulnar sensory latency difference of ≥0.50 ms. If a median sensory latency was absent, a median neuropathy was defined as a motor latency >4.7 ms and a normal ulnar sensory latency (<3.6 ms). Before the NCS, hand temperatures were obtained. The minimum hand temperature was set at ≥32°C during the electrophysiologic study.

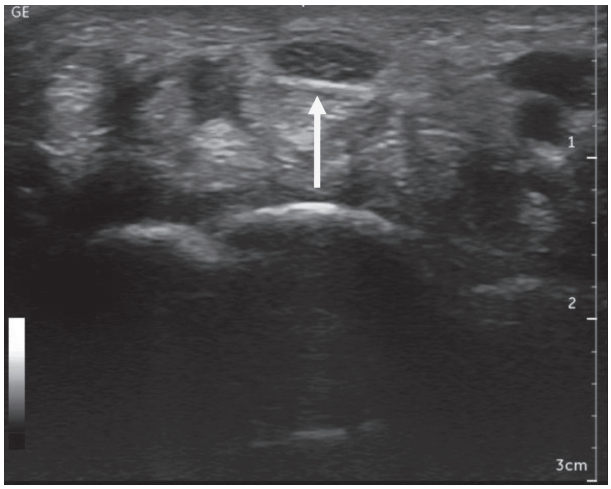

Figure 3 - Proximal carpal tunnel (at the semilunar bone level). Enlargement of the Median nerve CSA (15. 5 mm^2). Short Axis 12-5 MHz US Image

Figure 4 - Execution of the median nerve conduction study

Descriptive statistics analysis and univariate analysis were performed with statistical package SAS. Statistical significance was fixed for a p value ≤ 0.05.

Results

The subjects' mean age was 43, with an average of 13 years of experience as dairy parlor workers, with a mixed ethnic background. In particular, 37% (15 subjects) were from European countries while 63% (25 subjects) were non-European, including Indian (20), Tunisian (2), Pakistani (2), and Egyptian (1) (table 1).

Table 1 - Individual characteristics of study subjects

	All subjects (n=40), n (%)
Age (years), mean±SD	43.1±6.6
BMI, mean±SD	27.3±3.9
Right - handed	37 (92.5%)
Having hobbies or sports requiring high hand force	5 (12.5%)
Years in current job, mean±SD	13.4±10.6
Nationality	
European	15 (37.5%)
Indian	20 (50%)
Tunisian	2 (5%)
Pakistani	2 (5%)
Egyptian	1 (2.5%)

The majority of workers involved in the study (90%) did not have any other job at the time of the survey, the others were involved in multitasking activities in the dairy farm and only one declared that he was working in the industry.

Thirty percent of the population under study (12 subjects) did not declare previous work experiences in other sectors, while 20% (8 subjects) had been an animal breeder and thus often involved in other dairy activities such as fecundation. Finally, 20% (8) of the subjects performed other jobs (e.g. carpenter, taxi driver, warehouseman, trader), or were working in the building construction sector (6 workers representing the 15% of the subjects), while four of them (10%) were employed in industry.

Ultrasound results showed a prevalence of median nerve pathology (median nerve area >0.1 cm^2) in 55% of the workers in the dominant hand and 50% in the non-dominant hand, while NCS indicated a median mononeuropathy in 32, 5% of the workers in the dominant hand and 30% in the non-dominant hand.

When compared to NCS, the ultrasound showed a negative predictive value (NPV) of 37% and a positive predictive value (PPV) of 38% (table 2). Using these criteria, we found characteristic CTS symptoms in 25% of the dairy workers. The questionnaire showed a specificity of 93% and a sensitivity of 61% if compared with NCS. The negative predictive value of the test was 83% and its positive predictive value 80% (table 3).

Table 2 - Correlation between NCS results and US results (dominant hand); NPV=37%; PPV=38%

		Ultrasound		
		Positive	Negative	Total
NCS	Positive	5	8	13
	Negative	17	10	27
	Total	22	18	40

Table 3 - Correlation between NCS results and questionnaire results (dominant hand). NPV=83%, PPV=80%

		Ultrasound		
		Positive	Negative	Total
Questionnaire	Positive	8	2	10
	Negative	5	25	30
	Total	13	27	40

Discussion

The US examinations demonstrated a higher prevalence of median nerve impairment as compared to NCS results, but they also indicated low positive and negative predictive values (NPV=37%, PPV=38%). Moreover, the symptom questionnaire demonstrated a high level of specificity when compared to the NCS.

In the evaluation of the US results, it should be noted that there is not a universal agreement on the median nerve area threshold set to detect nerve impairment with ultrasound, which makes it difficult to compare our data with other studies.

Compared to Kolstrup (13), we focused uniquely on carpal tunnel syndrome and we added US and NCS to the questionnaire data. Although their study was focused on detecting different MSDs with a symptom questionnaire, they did report hand/wrist disorders in 10% of male dairy farm workers. Our results indicated positive CTS symptoms in 25% of the dairy parlor workers.

Patil et al. (17) studied a group of 66 dairy parlor workers and 58 non-parlor workers, which is greater than our group of 40 milking parlor workers and included non-parlor workers. However, their protocol did not include US examination but rather focused on a characteristic CTS symptoms and NCS. The results of the questionnaire were similar to our study results, as they found CTS symptoms in 27% of parlor workers. Median mononeuropathy was a slightly higher in the present study (32.5%) as compared to 25% in the Patil et al. (17) study of parlor workers.

Rosecrance (19) studied a group of 76 ewe farmers in Sardinia, to determine the risk of CTS from manual milking. As in the present study, they collected symptom data with a structured interview and performed NCS on all workers in the study. While they did not perform an ultrasound examination, they assessed the occupational risk for upper limb disorders via the Strain Index (10). The data were collected in dairy cooperatives close to the farms.

Using a combination of both characteristic CTS symptoms and NCS, they reported a 55% prevelance of CTS among Sardinian ewe milkers (manual), a much higher prevalence than in the present study sample (32%) using NCS alone. Their findings may indicate that manual milking of ewes puts the workers at greater risk of developing CTS as compared to industrialized milking. In the present study, however, we found a relatively high prevalence of wrist disorders among dairy parlor workers despite the improvement in milking routines through machinery.

When compared to the gold standard, our questionnaire showed a specificity of 93% and a sensitivity of 61%. Katz's hand symptom diagram (12) in 1990 had a similar specificity (90%), but our questionnaire seems to be more specific if we take into consideration the later studies on the hand symptom diagram. Franzblau et al. (8) and Bonauto et al. (3) reported a specificity of 84% and 87%, respectively when compared to the NCS.

This present study can be considered innovative for several reasons. First, we focused on workers who only performed milking activity, therefore addressing the single specific risk that can be attributed to performing only the milking routine. Secondly, we were able to gather all our data on the field, using portable devices for both the US and the NCS. This allowed us to reach a large number of workers in a relatively short time period, which would have been impossible had we examined these workers in the clinic.

Our results suggest that a simple questionnaire regarding characteristic CTS symptoms is highly associated with the distal median mononeuropathy

common with CTS among milking parlor workers. The questionnaire resulted to be a more effective screening method than ultrasound for both its predictive values and its general cost, as it does not rely on any machinery or trained personnel. Therefore, such a survey could be useful for screening large groups of workers in a relatively short time period. Workers that are positive for CTS symptoms could then be triaged for clinical examinations by a physician. Additional studies are needed to improve the use of ultrasound as a screening approach with CTS.

No potential conflict of interest relevant to this article was reported by the authors

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