Localized cervical pain: advantages and limits of ultrasound evaluation

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Abstract

Purpose Cervical pain is very frequent in the general population. In clinical practice, plain X-ray and, in selected cases, computed tomography or magnetic resonance imaging, are performed. However, the feasibility and utility of ultrasound examination have been poorly investigated. Aim of the present study was to evaluate whether ultrasound could be useful in the diagnosis of localized cervical pain.

Methods Subjects suffering from posterior cervical pain without irradiation to surrounding tissues were enrolled. After clinical and functional evaluation (demographic and anthropometric data, VAS at rest and during neck movements, symptoms duration, and characteristics of pain onset [atraumatic or traumatic]), an ultrasound exam of the cervical spine was performed according to standard protocols.

Results The anatomic structures of the neck district were visualized in 124/127 enrolled patients and pathological features were observed in 58. Significant ultrasound differences were registered between the patients with

traumatic and atraumatic onset of neck pain. In the first group, articular effusion, capsular bulging, disalignment and avulsion of the articular apex were observed, whereas in the latter cortical irregularities, osteophytosis, and articular ankylosis were prevalent.

Conclusions Ultrasound examination can be used as diagnostic tool in the evaluation of selected patients suffering from localized cervical pain, particularly in cases of pain due to traumatic injuries.

Keywords Cervical spine · Pain · Trauma · Whiplash · Ultrasound

Sommario

Scopo del lavoro Il dolore del rachide cervicale è molto diffuso, specialmente nella popolazione femminile di mezza età. Diversi esami strumentali vengono comunemente utilizzati, fra i quali la radiografia convenzionale e, in casi selezionati, la Tomografia Assiale Computerizzata e la Risonanza Magnetica. Tuttavia, l'utilizzo dell'esame ultrasonografico è stato raramente riportato in letteratura. Scopo del presente studio è quello di valutare l'utilità dell'ecografia nella diagnosi del dolore localizzato al rachide cervicale.

Metodi Sono stati selezionati pazienti affetti da dolore posteriore del rachide cervicale senza irradiazione ai tessuti circostanti. Dopo una valutazione clinica e funzionale (dati demografici ed antropometrici, dolore a riposo e durante i movimenti del collo misurato su scala VAS, durata dei sintomi e caratteristiche di insorgenza del dolore [traumatica, a-traumatica]), è stato eseguito un esame ecografico del rachide cervicale secondo protocolli standard. **Risultati** Le normali strutture del collo (ossa, articolazioni, muscoli, legamenti) sono state visualizzate in 124/127 soggetti ed in 58 di essi sono state riscontrate

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alterazione ecografiche di significato patologico. Fra i pazienti con genesi traumatica e atraumatica l'analisi statistica ha evidenziato differenze significative in termini di età, BMI, durata dei sintomi ed intensità del dolore. Nei soggetti con danno traumatico l'esame ecografico ha dimostrato effusione articolare e bulging capsulare, disallineamento dei capi articolari ed avulsione dell'apice articolare; nei pazienti con danno a-traumatico sono state invece osservate alterazioni degenerative artrosiche (irregolarità corticale, osteofitosi, anchilosi).

Conclusioni L'esame ecografico può essere utilizzato come indagine di primo livello in alcuni pazienti affetti da interessamento del rachide cervicale, soprattutto nel dolore post-traumatico.

Introduction

Cervical pain is a common medical condition in the general population, which may often limit one to perform daily activities [1]. It occurs more frequently in women, and with increasing age, a greater number of patients are seen by family physicians or go to outpatient clinics [2]. Degenerative (osteoarthritis, disc pathology, etc.), traumatic (acceleration–deceleration injury [i.e., whiplash], sport accidents, etc.), and inflammatory diseases (radiculopathy, rheumatoid arthritis, ankylosing spondylitis, etc.) can be the cause of cervical pain [3–5]. Moreover, the pain may depend on conditions directly affecting the neck musculature, such as postural disorders (also work related), fibromyalgia, and/or polymyalgia rheumatica [6]. In the clinical practice, diagnosis is usually based on clinical examination and plain X-ray, whereas computed tomography (CT) and magnetic resonance imaging (MRI), which are costly and time-consuming, are reserved for specific conditions when a major damage is suspected or when the functional recovery is delayed or unsatisfactory [7, 8]. Ultrasonography (US) could be an attractive adjuvant method in the investigation of some cervical pathologies because of the broad availability and affordability of the equipment [9]. However, its feasibility and utility in the evaluation of cervical diseases have been poorly investigated. At present, studies on large samples have not been produced on peer-reviewed indexed journals, so the question whether US can provide some useful information in selected patients is still unknown. The aim of the present paper is to investigate whether US could demonstrate pathological features of the neck district in a large number of patients suffering from posterior cervical pain without irradiation to surrounding tissues.

Materials and methods

Participants

The study was performed according to the Declaration of Helsinki, and informed written consent was obtained from all subjects. Patients aged less than 65 years referred to the ultrasound service with pain referred exclusively in the posterior cervical region were enrolled. The clinical evaluation was performed by skilled specialists on the basis of standard neurological diagnostic methods according to evidence-based medicine recommendations [10]. The exclusion criteria were patients aged more than 65 years (to exclude advanced osteoarthritis) and the presence of neurological deficit (myelopathic or radiculopathic signs), discitis, and previous neck surgery. In the enrolled participants, demographic (age and sex), anthropometric (height, weight, and BMI), and clinical data were collected. Pain intensity (VAS at rest and during neck movements), symptoms duration, and pain onset (traumatic or atraumatic) were registered.

Ultrasound exam

Patients underwent a US evaluation of the cervical spine using a high-resolution, multifrequency (5–12 MHz) linear array transducer (*Philips IU22*). Care was taken to hold the probe perpendicular to the target tissue to avoid anisotropy. The exams were performed by the same radiologist with ultradecennial experience in musculoskeletal imaging. In detail, with the patients lying prone and the head slightly facing away from the side to be examined, the posterior neck region was investigated by means of multiplanar scans (longitudinal, transverse, oblique, and coronal) according to standard protocols [11, 12]. In particular, the anatomical structures (bones, joints, muscles, ligaments, and paravertebral spaces) localized from the first to the seventh cervical vertebra were examined.

Statistical analysis

Data are reported as mean $\pm$ SD for continuous variables, whereas categorical and dichotomous variables are reported as frequencies and percentage. The two-sample Student's *t* test was used to compare continuous variables when the distribution of data was normal; the Wilcoxon rank-sum test was used otherwise. The Chi-square test was used to evaluate associations between categorical data. The significance level was determined at $p < 0.05$.

Results

In the period between January 2013 and February 2015, 127 subjects (39.3 ± 11.5 years, range 20–65 years, M:F ratio 49:78) suffering from cervical pain without signs of radiculopathy were enrolled. Out of three subjects, the US scans clearly depicted the anatomic structures of the neck (systematic osseous landmarks, joints, muscles, ligaments) (Fig. 1). The demographic and clinical data of the patients are reported in Table 1. The examination showed pathological findings only in 58 (45.6 %) patients, and no differences were observed between US positive and negative subjects in all parameters evaluated, except for age (Table 2). Therefore, the US-positive patients were divided in two subgroups according to the traumatic or atraumatic onset of pain. Patients with traumatic injuries were younger, had a lower BMI, and reported more pain (both at rest and during neck movements). The symptoms duration

Table 1 Demographic and clinical data of enrolled patients at baseline

Number of patients	127
Age (years)	39.3 ± 11.5
M:F ratio	49:78
BMI	23.2 ± 1.9
Symptoms duration (weeks)	5.7 ± 3.4
VAS at rest	2.3 ± 1.4
VAS during activities	4.5 ± 1.3
Traumatic injuries	46 (36.2 %)
Whiplash	19 (41.3 %)
Sport accidents	27 (58.6 %)
Atraumatic injuries	81 (63.7 %)
Idiopathic	60 (74 %)
Work-related	21 (25.9 %)

Fig. 1 Normal ultrasound features: **A** spinous process (Sp) at the level of C6, vertebral arch (Va), and articular process (Ap) (axial scan plane); **b** between the spinous processes (Sp) at the level of C5–C6, the overlying ligament (arrows) and the interspinous ligament (*) can be visualized (longitudinal scan plane); **c** the articular complex

between C6–C7 and C7–D1 and their joint spaces (circles) are visualized (coronal scan plane); **d** the neck musculature is depicted at the level of C5–C6 (1 trapezius, 2 splenius capitis, 3 semispinalis colli, 4 splenius colli, 5 semispinalis capitis, 6 levator scapulae) (axial scan plane)

Table 2 Positive and negative ultrasound findings: demographic and clinical data

	Positive	Negative	<i>p</i>
Number of patients	58	69*	
Age (years)	44.8 ± 11.9	34.6 ± 9	0.000
M:F ratio	26:32	23:46	0.1
BMI	23.6 ± 1.7	22.8 ± 2	0.02
Symptoms duration (weeks)	5.1 ± 3.4	6.1 ± 3.3	0.1
VAS at rest	2.1 ± 1.2	2.5 ± 1.5	0.1
VAS movements	4.3 ± 1.4	4.7 ± 1.2	0.09
Traumatic injuries	23 (39.6 %)	23 (33.3 %)	0.4
Whiplash	9 (39.1 %)	9 (39.1 %)	0.7
Sport accidents	14 (60.8 %)	14 (60.8 %)	0.7
Atraumatic injuries	35 (60.3 %)	46 (66.6 %)	0.5
Idiopathic	25 (71.4 %)	29 (63 %)	0.5
Work-related	10 (28.5 %)	17 (36.9 %)	0.5

3 subjects with unsatisfying US records were included in the negative group

compared with the atraumatic counterpart was shorter (Table 3). At US exam (Table 4), articular effusion, capsular bulging, and disalignment and avulsion of the articular apex were more frequently observed in traumatic injuries (i.e., whiplash, sport accidents) (Fig. 2), whereas subjects with atraumatic pain showed in most cases significant osteoarthritic changes of different degrees (cortical irregularities, osteophytosis, and articular ankylosis) (Fig. 3).

Discussion

This study shows that US is able to identify the anatomical structures of the neck district in majority of the patients. In particular, according to several authors [12–16], US is at least sufficiently reliable and accurate in the demonstration of cervical paravertebral anatomy, facilitating the localization and imaging of muscles, superficial ligaments, spinal nerve roots, vessels, as well as bony landmarks and interarticular space of facet and articular joints. This is of

Table 4 US findings in patients with traumatic and atraumatic injuries

	Traumatic	Atraumatic	<i>p</i>
Number of patients	23	35	0.02
US features			
Articular effusion	15 (65.2 %)	11 (31.4 %)	0.01
Capsular bulging	9 (39.1 %)	4 (11.4 %)	0.01
Cortical irregularity	6 (26 %)	24 (68.5 %)	0.000
Osteophytes	2 (8.6 %)	19 (54.2 %)	0.000
Ankylosis/fusion	0	6 (17.1 %)	0.03
Disalignment	5 (21.7 %)	0	0.000
Avulsion	2 (8.6 %)	0	0.02

clinical relevance because these structures can possibly be used as “imaging” landmark for therapeutic purposes [14–17] as demonstrated while performing image-guided injections (for nerves or articular pathologies) of the cervical spine [18, 19]. In particular, it has been reported that US, when compared to fluoroscopy or CT, is an excellent tool for “visualizing” (accuracy 68–100 %) and hence “avoiding” vascular injury during interventional procedures [18], whereas fluoroscopy can only “detect” that the tip of the needle is intravascular (after the fact) [20]. Moreover, US reduces the timing of the procedure and avoids radiation both for the patient and the operator. Besides the ability to evaluate the anatomical structures, the study shows that US can be used as a diagnostic method in the evaluation of selected patients suffering from cervical pain without irradiation. Indeed, US showed the presence of acute (articular effusion, capsular bulging, disalignment, and avulsion) and chronic (osteoarthritic changes) abnormalities in patients with traumatic and atraumatic injuries, respectively. In this regard, advanced osteoarthritic changes are easily revealed by plain X-ray, whereas US adds new information in traumatic damage. This is clinically relevant because such pictures can be obtained only by means of costly and time-consuming investigations (i.e., TC and MRI). The US findings observed can explain the neck pain reported from the

Table 3 Demographic and clinical data in patients with positive US findings, divided according the onset modalities

	Traumatic	Atraumatic	<i>p</i>
Number of patients	23/58 (39.6 %)	35/58 (60.3 %)	0.02
Age (years)	34.4 ± 9.6	51.7 ± 7.7	0.000
M:F ratio	16:7	10:25	0.002
BMI	22.7 ± 1.6	24.2 ± 1.5	0.001
Symptoms duration (weeks)	3 ± 1.2	6.6 ± 3.7	0.000
VAS at rest	3 ± 1.1	1.5 ± 0.8	0.000
VAS movements	5.2 ± 1.5	3.7 ± 1	0.000

Fig. 2 Pathological ultrasound features in traumatic cases: **a** capsular bulging (*arrows*) and effusion in the articular space (*) are seen at the level C5–C6 (*coronal longitudinal scan plane*) after a sport injury

(rugby); **b** an avulsion of the articular apex of C4 (*dotted circle*) is observed after a whiplash trauma (*oblique scan plane*)

Fig. 3 Pathological ultrasound features in atraumatic cases: **a** cortical irregularities (*Ir*) at the C3–C4 level with small effusion into the articular space (*dotted circle*) (*longitudinal scan plane*); **b** moderate osteoarthritic changes at the C3–C4 level can be observed; *Ir* cortical irregularities, *dotted circle* articular effusion (*longitudinal scan*

plane); **c** at the level C4–C5 and C5–C6, capsular bulging (*arrows*) and degenerative changes (*) of the articular spaces are visualized (*longitudinal scan plane*); **d** ankylosis/fusion of the facet joints (*Fj*) (*arrow*) (*oblique scan plane*)

patients. In this regard, it is well known that excessive facet joint compression and capsular ligament strain arising after whiplash injury or neck trauma [11, 21] and/or facet joint degeneration, found more commonly in the elderly, can stimulate the nociceptive elements (free and encapsulated nerve endings, nociceptors, and mechanoreceptors) contained in the facet joint and capsule [22, 23]. These structures, which are innervated by the medial branches of the dorsal rami [24], may also be responsible for cervicogenic headaches (C2–C3 facet joint) and/or pain in the suboccipital region [11, 20].

On the other hand, it must be underlined that in a significant percentage of patients (54.3 %, 69/127), US examination did not reveal any evident cervical spine abnormality. This is not surprising because in some cases, pain may stem from damaged structures not directly visualized by US (i.e., deep structures such as discs, nerves, etc.) or may depend on muscular strain or inflammation. In these specific cases, more appropriate exams (CT, MRI, EMG, etc.) must be considered. To our best knowledge, this is the first systematic study aiming to investigate the utility of US in the evaluation of posterior cervical pain without irradiation in a large number of patients. However, some limitations must be acknowledged. First, as previously mentioned, US was not able to depict some anatomical structures because the resolution was limited in depth with interrupted view due to bony artifacts or acoustic shadows [25]. Moreover, the visualization of other tissues was very challenging, especially in obese and/or short-necked subjects and/or patients with advanced cervical facet arthritis [11, 25]. Second, a comparison with other imaging exams was not performed. In this regard, MRI is considered the “gold standard” modality for spine visualization [8] because of its excellent tissue resolution and superior visualization of intervertebral discs [26]. Third, the US was not performed immediately in acute cases. It is reasonable that, with an early examination, more pathological features could be detected because of the larger amount of effusions, which underwent reabsorption in the following days.

In conclusion, US is able to reveal anatomical landmarks useful for therapeutic purposes during image-guided injections in majority of cases. Moreover, being non-invasive, broadly available, low-cost, time-saving, and without ionizing radiation, it can be used as first approach-line method especially in acute injuries, as it adds important information that cannot be revealed by plain X-ray or can be obtained only with costly and time-consuming investigations. However, because an in-depth knowledge of sonoanatomy of cervical spine is mandatory, this method requires experience and considerable learning curve to achieve good visualizations.

Compliance with ethical standards

Conflict of interest The authors declare no potential conflicts of interests with respect to the authorship and/or publication of this article. They do not have a financial relationship with the organization that sponsored the research. The authors have full control of all primary data and agree to allow the journal to review their data if requested.

Ethical approval The experiments comply with the current laws of the country in which they were performed. All procedures performed in study involving human participants were in accordance with the ethical standards of the institutional and/or national committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed written consent was obtained from all the subjects.

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