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Review Article

A Review of the Clinical Use of Ultrasound in Korean Traditional Medicine



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ABSTRACT

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This study was performed to evaluate research studies utilizing ultrasound diagnostic units, the practitioners who performed the ultrasound assessments, and how they had been used primarily in tandem with the Korean Medicine Advanced Searching Integrated System. This study identified 46 studies following a literature search, and discovered that a Korean medicine doctor led the ultrasonography in 13 studies, a medical technician was responsible in 6 studies, a roentgenologist carried it out in 5, and 19 of the studies did not specify who had conducted it. Ultrasonography had been actively used in the course of the clinical practice of Korean medicine, and it may serve as a useful and reliable diagnostic tool for evaluating the effectiveness of Korean medicine. The results of this study will help to promote more ultrasound studies in the future.

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Introduction

An ultrasound wave is a high-frequency sound wave that cannot be heard by the unassisted human ear. Since ultrasound waves have high frequencies, they travel poorly through air and travel well through liquids and solids [1]. It is believed that most people can hear sounds at frequencies up to 20,000 Hz. An ultrasound wave is defined as a high-pitched sound, equal to or above 20,000 Hz [2].

An ultrasound wave contains significant force, so it can generate heat or cause cavitation, i.e. create a vacuole in the living body. However, the ultrasound waves which are used in diagnostic devices, do not cause these phenomena because the wavelengths used do not possess enough energy making these devices safe to use without causing exposure to radiation.

Medical ultrasonography is a diagnostic imaging technique that can enable visualization of muscles, tendons whose size, structures, and pathological degrees of damage can be determined in internal organs, in real-time tomography. Ultrasound waves between 3.5 and 5.0 MHz are mainly used for observing organs in the

abdominal lumen, and those between 5 and 15 MHz are used for observing superficial organs or tissues [1,3].

Cutting-edge imaging equipment, such as ultrasound diagnostic units (CT, MRI, and PET), have been developed and advances based on human anatomy. Research into ultrasound diagnostic units have been actively studied because they are non-invasive, they do not pose any risk of radiation exposure, they can be performed directly in the clinical setting, and they allow real-time observation [4]. The Ministry of Health and Welfare recently expanded the coverage of the National Health Insurance system to cover upper abdomen ultrasound scans from April 1st, 2018, as a follow-up measure to protect citizens more closely.

A number of case studies have reported that Korean medical clinics employ ultrasound diagnostic units in clinical treatments. Oh et al [5] analyzed the trends of ultrasound diagnostic units in Korean medical care. However, they only reported the number of publications, the number of publications issued by institutions, the number of publications by journals, and the types of diseases. It is not known how many ultrasound diagnostic medical units are used

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in the clinical setting. The objective of this study was to evaluate the status of studies using ultrasound diagnostic units, who used them, and how they had been used. This information was retrieved using the Korean Medicine Advanced Searching Integrated System (OASIS).

Materials and Methods

Search method

This study retrieved abstracts and full-text publications that were registered with OASIS, or published on or prior to October 8th, 2019. Three researchers independently searched for electronic journals in the OASIS. The search keywords used were “ultrasound” and “ultrasound in Korean.” The literature lists of the 3 researchers were merged after completing the literature search.

Selection criteria and outcome assessment

This review selected clinical studies using ultrasound diagnostic units. Each researcher selected or excluded literature independently. Any discrepancy was resolved by discussion between the researchers to decide whether the literature should be included or not. The selected studies were categorized by ultrasound diagnostic unit use, year of publication and then analyzed. Moreover, those using ultrasound diagnostic units were also analyzed.

Results

Description of the included studies

Sixty-nine studies were identified using the keyword “ultrasound,” and 34 studies were found using the term “ultrasound in Korean.” Twenty-nine duplicated studies were excluded which left 74 articles to be included in the review. Publications and case studies not using an ultrasound diagnostic unit were excluded. Following the first screening, 46 studies were identified, including studies evaluating related research trends. Upon examination of the full text 46 studies [5-50] that satisfied the selection criteria of this study were included in this review (Fig. 1).

These 46 studies were categorized into changes in blood flow (Table 1), joints and muscles (Table 2), abdomen (Table 3), and other clinical applications and discussions (Table 4). Furthermore, the percentage of publications by year (Fig. 2) and the user (Fig. 3) are presented.

Measuring changes in blood flow

Fifteen out of the 46 studies examined changes in blood flow. Among these 15 studies, 9 measured cerebral blood flow and evaluated treatment effects. Moreover, 5 studies measured the changes in blood flow observed during Korean medicine treatments. One study examined the changes in blood flow at the acupoints on the face of patients with facial paralysis.

Six of the 9 studies were conducted by medical technicians which measured cerebral blood flow and evaluated treatment effects, while 1 of the studies was performed by a roentgenologist. Two studies did not mention who conducted the examination.

Five studies measured the changes in blood flow during Korean medicine treatments. All of them confirmed the effects of the Korean medicine treatments on blood flow, using ultrasound, but no study mentioned who operated the ultrasound device.

The study that observed the changes in blood flow at the

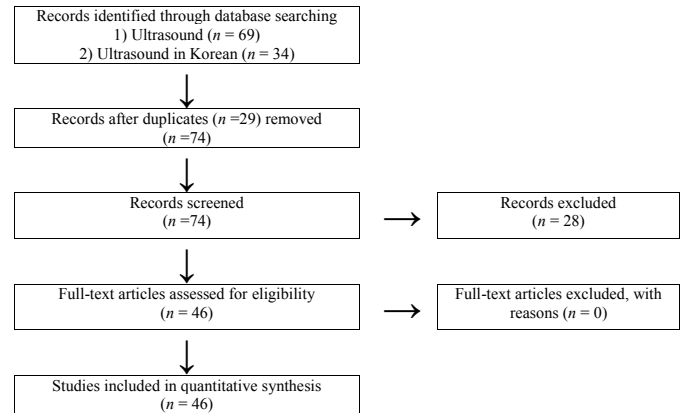


Fig. 1. Flowchart of trial selection process.

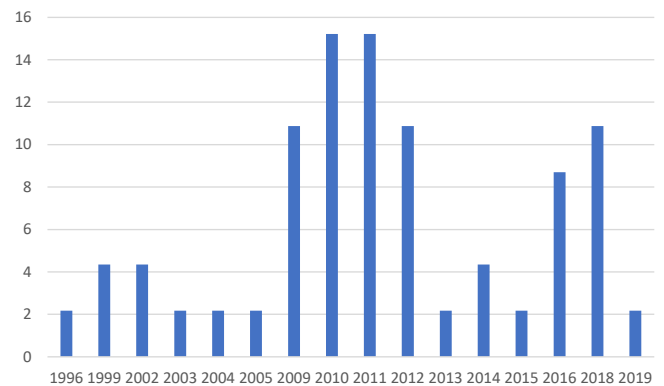


Fig. 2. The percentage of included studies by year.

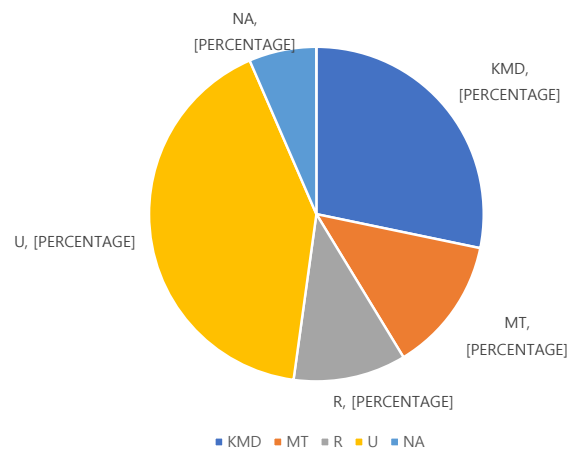


Fig. 3. The number and percentage of included studies by ultrasound user. KMD, Korean medicine doctor; MT, medical technician; NA, not applicable; R, Roentgenologist; U, unknown.

Table 1. Measuring the Changes in Blood Flow by Ultrasonography.

Study ID	Study contents and results	User of ultrasound
Measuring cerebral blood flow and evaluating treatment effects		
Park (2011) [6]	Dampness-phlegm diagnosed patient group and severe ICA stenosis were clarified ($p < 0.05$)	MT
Jang (2003) [7]	Herb-medicine has an effect on MCA stenosis using TCD	MT
Kim (2004) [8]	In blood flow velocities in the BA between dizziness patients and normal subjects suggests that dizziness is related to blocking of blood flow in the BA and that diagnosis and prognosis can be made through TCD	MT
Kwak (2012) [9]	Dampness-phlegm diagnosis diagnosed group and left ventricular hypertrophy were clarified ($p < 0.05$)	MT
Kang (2009) [10]	No significant correlation was observed between abnormal ambulatory results and CCA-IMT	MT
Kim (2014) [11]	Carotid IMT and The Korean Standard Pattern Identification for Stroke in Ischemic Stroke Patients were founded	R
Um (2010) [12]	In the mean velocity, peak systolic velocity and pulsatility index between metabolic syndrome group and normal group suggests hemodynamic disorder ($p < 0.05$)	MT
Chang (1996) [13]	In the blood flow velocity between ischemic stroke patients and normal healthy adults ($p < 0.05$)	U
Han (2009) [14]	It was confirmed that hemiparesis induces the reduction of the peripheral blood flow velocity in the systolic phase by using doppler ultrasonography	U
Measuring the changes in blood flow during Korean medical treatments		
Yoon (2010) [15]	Moxibustion has an effect on peripheral blood flow in stroke patients with hemiplegia	U
Kim (1999) [16]	Uwhangchungsimwon decreases pulsatility index and breath-holding index in cerebral artery, which is due to dilation of cerebral resistance vessels	U
Moon (2005) [17]	Gastrodiae extract significantly decreased breath-holding induced CO ₂ reactivity ($p < 0.05$)	U
Yoon (2011) [18]	Moxibustion on LI4, TE3, TE5 and LI11 on the affected side of stroke patients increase the peripheral blood flow in the affected arm	U
Lim (2010) [19]	Recovery time of blood flow velocity by ultrasonography doppler was significantly different between the Yin and Yang tendency groups after cold stress ($p < 0.05$)	U
Yin (2009) [20]	Doppler ultrasonography examination was effective in evaluation at values of the symptom, degree of paralysis, duration of treatment	KMD (after 3 w education from specialist)

CCA, common carotid artery; IMT, intima-media thickness; KMD, Korean medicine doctor; MT, medical technician; NA, not applicable; R, roentgenologist; TCD, transcranial doppler; U, unknown.

acupoints on the face of patients with facial paralysis, measured the observed changes using Doppler ultrasonography. It was measured by a Korean medicine doctor, who was trained by a specialist for 3 weeks (Table 1).

Joins and muscles

Twelve of the 46 studies examined joints and muscles in patients. Among these 12 studies, 8 studies were conducted to evaluate how to use ultrasonography efficiently for the treatment of joints and muscles. In 7 of the 8 studies, Korean medicine doctors conducted ultrasonography as the main medical practitioner, while 1 study did not mention who carried out the procedure. These 8 studies used ultrasonography while conducting acupuncture therapy and herbal acupuncture therapy. Four studies used ultrasonography

to evaluate the condition of joints and muscles. These 4 studies used ultrasonography for examining joints, though they did not mention who conducted the examination (Table 2).

Abdomen

Fifteen of the 46 studies evaluated the abdomen of patients using abdominal ultrasonography (3.5 and 5.0 MHz). Three studies were conducted to ensure treatment accuracy by identifying the location and distance, during Korean medicine treatments. Six studies compared pre- and post-treatment ultrasonography for diagnosis and treatment. Two studies used ultrasound for the abdomen to determine treatment effects. Four studies evaluated gastric emptying measurements. Among the 3 studies for discerning location and distance, 2 studies were conducted by a Korean

Table 2. Measuring Joints and Muscles by Ultrasonography.

Study ID	Study contents and results	User of ultrasound
Evaluating efficiently for treating joints and muscles		
Park (2011) [21]	Ultrasonography-guided acupotomy therapy had effect on posterior headache, musculoskeletal by traffic accidents	U
Kim (2019) [22]	Soyeom pharmacopuncture therapy on TPVS under ultrasonic guidance could be more effective on pain reduction and improvement of treatment satisfaction with rib fracture compared to those who were treated with non-guided pharmacopuncture therapy	KMD
Ahn (2016) [23]	Ultrasonography can be useful for diagnosing rib fracture and also helpful for safety and accuracy of pharmacopuncture	KMD
Jeong (2016) [24]	Ultrasonography-guided bee venom pharmacopuncture has a meaningful clinical effect on the improving shoulder pain, disability and ROM	KMD
Lim (2011) [25]	Ultrasonography-guided acupotomy therapy had effect in improving symptoms of lateral epicondylitis	KMD
Kim (2011) [26]	Ultrasonography-guided acupotomy therapy had notable effect in improving symptoms of peroneal nerve palsy	KMD
Kim (2012) [27]	Ultrasonography-guided acupotomy therapy had notable effect in improving symptoms of common peroneal nerve palsy	KMD
Park (2010) [28]	Ultrasonography-guided acupotomy therapy had an effect of reducing the wrist ganglion size	KMD
Evaluating the condition of joints and muscles		
Lee (2009) [29]	Sonograph can be more utilized than X-ray for differential diagnosis especially sensitive on the problem of effusion	U
Kim (2010) [30]	When evaluating joint ultrasonography, Beevenom acupuncture was effects on pain, physical function and knee joint effusion	U
Kim (1999) [31]	For shoulder joints function and sonography, it was found that the pronation and internal version ranges are restricted indicating close relationship between mortor restriction of shoulder joints and scapular	U
Park (2012) [32]	Intraarticular sonographic findings including cartilage thickness was correlated with extraarticular findings including PAT and a symptom of knee pain ($p < 0.05$)	U

KMD, Korean medicine doctor; MT, medical technician; NA, not applicable; PAT, Pes Anserinus tendinopathy; R, roentgenologist; TPVS, thoracic paravertebral space; U, unknown.

medicine doctor, and 1 study did not specify who conducted the procedure. Among the 6 studies comparing Korean medicine diagnosis and treatment, ultrasonography was conducted by a roentgenologist in 3 studies, and by a Korean medicine doctor in 2 studies, while 1 study did not specify the acting practitioner. The 2 studies which evaluated treatment effects, examined the treatment effects of Korean medicine treatments on patients with non-alcoholic fatty livers. A Korean medicine doctor examined the ultrasonography images directly in 1 study, while a roentgenologist examined them in the other study. All 4 studies on gastric emptying capability assessed the relationship between the Korean medicine diagnosis and gastric emptying capability, and none of these studies mentioned who conducted ultrasonography (Table 3).

Other clinical applications and review

One study out of the 46, covered other clinical applications, while 3 studies were literature reviews. The former presented the basis for the diagnosis of sinusitis using ultrasound, by comparing the X-ray of sinus and the ultrasonograph of the sinus, but it did not mention who conducted the procedure. The 3 literature review studies presented the status of ultrasound diagnostic device use in Korean medicine clinical treatments, provided a basis for utilizing ultrasound diagnostic devices for observing internal organs, and included a study on ultrasound-guided acupuncture (Table 4).

Discussion

As science and technology have developed, ultrasound waves have become useful in various fields such as construction [51], robotics [52], and beauty [53]. Ultrasound waves pose no harm to the human body and are also actively used in modern medicine. Although its history as a diagnostic imaging tool is shorter than that of other methods, it has made remarkable progress in a very short time, and has already been established as a diagnostic method. It has become one of the most important imaging modalities in modern medicine. In line with these advancements, ultrasound findings corresponding to various physiological and pathological conditions have become more accurately diagnosed. Accordingly, Korean medicine practitioners also actively employ ultrasonography in the diagnosis and clinical treatment of patients due to the legal restrictions on the use of ultrasonography in Korean medicine by Korean medicine doctors. The grounds for Korean medicine doctors to use ultrasonography is still weak. The objective of this study was to discuss and evaluate the studies utilizing ultrasound diagnostic units, who was the user of these units, as well how they have been used. This information was retrieved using OASIS. This study identified 46 studies [5-50] after conducting a literature search and report that 38 of the 46 studies were published in the last 10 years. It was also confirmed that ultrasonography related studies was an increasing trend. Among the 46 studies, a Korean medicine doctor led ultrasonography in 13

Table 3. Measuring Abdomen by Ultrasonography.

Study ID	Study contents and results	User of ultrasound
Identifying the location and distance during Korean medical treatments		
Han (2016) [33]	The possibility of estimating the thickness of the abdominal wall by looking at the characteristics of patients with functional dyspepsia, including the sternocostal angle.	U
Nam (2010) [34]	Repeatability and reproducibility of the ultrasonography device system for measuring distance from CV13 to pancreas was acceptable	KMD
Kim (2011) [35]	From the abdominal surface of Sangwan (CV13) to peritoneum in front of anterior surface of liver, 9 MHz linear probe and solid gel pad were acceptable	KMD
Comparing the pre- and post-treatment		
Ryu (2010) [36]	Herbal medication and acupuncture therapy were effective on acute appendicitis diagnosed by abdominal ultrasonography	U
Kim (2013) [37]	In accordance with the Sasang constitutional type under the ultrasonography, examine was conducted for differences in the hepatic function disorders and prevalence rates of liver diseases	R
Kim (2002) [38]	Ultrasonographic appearance proved that herbal medicine was effective on the ovarian tumor	R
Hwang (2012) [39]	ultrasonography was used to estimate difference of retroverted uterus by dysmenorrhea, mass of low abdomen, pressure pain, cold of menstrual blood, dyspareunia	KMD
Park (2012) [40]	Ureine myoma ultrasonography differed in Sasang constitutional medical distribution, and Soyangin was more portion than the other	KMD
Cho (2011) [41]	ultrasonography was used to estimate the sum of uterine walls is related with CA-125 and blood stasis pattern	R
Determining treatment effects		
Baik (2016) [42]	In patients with fatty liver, ultrasonography was performed to observe changes in fatty liver and to improve the objectivity of treatment results.	KMD
Park (2009) [43]	Herbal obesity treatment was effective on decreases weight, BMI and liver function and NAFLD on real ultrasonography	R
Checking the relationship between Korean diagnosis and gastric emptying capability		
Nam (2018) [44]	Gastric emptying measured by abdominal ultrasonography could be an indicator to diagnose Stomach Qi Deficiency in functional dyspepsia patients	U
Baek (2015) [45]	Gastric emptying measured by abdominal ultrasonography could be an indicator to diagnose Spleen Qi Deficiency in functional dyspepsia patients	U
Ha (2018) [46]	Zusanli electroacupuncture was confirmed through ultrasonographic gastric emptying in healthy participants	U
Cho (2018) [47]	Gastric emptying measurement by ultrasonography may be a method for Korean medical questionnaires or for some dyspepsia-related and deficiency-related items	U

KMD, Korean medicine doctor; R, roentgenologist; U, unknown.

Table 4. Other Clinical Application and Review by Ultrasonography.

Study ID	Study contents and results	User of ultrasound
Diagnosis of sinusitis using ultrasound		
Cho (2002) [48]	Ultrasonographic diagnosis reflects the symptoms of sinusitis like X-ray diagnosis and is a valuable tool to screen prognostic factors such as mucosal thickening, air-fluid level and cyst	U
Review		
Oh (2018) [5]	Review studies about ultrasonography in Korean medicine, and found encouraging but limited usage of ultrasonography in Korean medicine.	NA
Baik (2014) [49]	Provided evidence for development of scientific and objectification of Korean medicine by using imaging equipment and ultrasonography	NA
Kim (2018) [50]	Analyze domestic and foreign clinical research into ultrasonography-guided Korean medicine acupuncture	NA

NA, not applicable; U, unknown.

studies, a medical technician conducted the procedure in 6 studies, a roentgenologist carried it out in the course of 5 studies, and 19 of the studies did not specify who conducted the procedure. In other words, ultrasonography was chiefly conducted by Korean medicine doctors (28%), a more frequent occurrence than was found in studies conducted by medical technicians or roentgenologists. Considering that these studies were conducted mainly by Korean medicine doctors, those studies not specifying who carried out ultrasonography may have been performed by Korean medicine doctors, suggesting that ultrasonography was conducted by Korean medicine doctors in a greater total than 13 studies. The results implied that ultrasonography was actively used by Korean medicine doctors for clinical treatments.

Yin et al [20] showed blood flow at the acupoints on the face of the patients with facial paralysis after receiving 3 weeks of training, which suggested that Korean medicine doctors could use ultrasonography for their clinical treatment after receiving professional training of similar duration.

The 46 studies were composed of 15 studies on the changes in blood flow, 12 studies on joints and muscles, 15 studies on the abdomen, 1 study on other clinical applications, and 3 literature review studies. The studies related to the changes in blood flow measurement of cerebral blood flow, examining the treatment effects, and evaluating the effects of Korean medicine treatments by measuring changes in blood flow during the treatments. Studies related to joints and muscles consisted of studies that used ultrasound waves to increase the safety and reproducibility when applying acupuncture or herbal acupuncture to joints and muscles, as well as those for evaluating treatment effects following treatments. The studies related to abdominal ultrasound were primarily for identifying the distances between the needles and the abdominal organs in order to evaluate the safety of abdominal acupuncture, for the sake of understanding the correlation between Korean medicine treatments and the results of ultrasonography, and for determining treatment effects. Moreover, there were studies comparing X-ray and ultrasonography in diagnosing sinusitis and literature review studies. Overall, the results indicated that ultrasound waves were useful for evaluating the effectiveness of Korean medicine treatments and enhancing rigor and reproducibility during treatments.

Consequently, ultrasonography has been actively used in the clinical practice of Korean medicine, and it is a useful diagnostic tool for evaluating the effects of Korean medicine, and increasing reliability and reproducibility. However, special attention should be given to interpreting the results of this review because only publications retrieved from OASIS were included. Publications from international journals using international databases were not included. The aim of this review of ultrasonography use in Korean medicine treatments, was to encourage more diverse ultrasound studies in the future.

Conclusion

Ultrasonography has been actively used in clinical practice settings of Korean medicine, and it is a useful diagnostic tool for evaluating the effects of Korean medicine, as well as increasing the robustness and reproducibility of results. This review has provided the scope for broadening the use of ultrasound studies in the future.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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