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Methods: Ultrasound-guided Oriental medicine acupuncture studies were retrieved from PubMed, CNKI, KISS, NDSL, and OASIS. "Ultrasound" was combined with "The Oriental medicine acupuncture" to retrieve articles. The Oriental medicine acupuncture was limited to acupuncture, electroacupuncture, acupotomy, and pharmacopuncture. The search was performed using the Boolean operators "AND" and "OR" , and a cross-search of "Patient and Intervention" was performed (Table 1). In these 17 studies the ultrasound frequency range where mentioned, was 5-14 MHz.

Conclusion: This study provided basic data as reference for the design of more diversified and systematic clinical research in the domestic Oriental medicine community in the future.

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Original Article
Trends in Domestic and Foreign Clinical Research on Ultrasound-Guided Acupuncture
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ABSTRACT
Background: The purpose of this study was to analyze domestic and foreign clinical research into ultrasound-guided Oriental medicine acupuncture.
Methods: Ultrasound-guided Oriental medicine acupuncture studies were retrieved from PubMed, CNKI, KISS, NDSL, and OASIS.
Results: Of 6,260 articles, 17 articles were selected. There was 1 article in 2004, 1 in 2008, 2 in 2011, 1 in 2012, 4 in 2013, 3 in 2016, 2 in 2017, and 3 in 2018. Of the 17 selected articles 6 articles were studies of omalgia, 4 of knee pain and 2 of peroneal nerve palsy. In addition, there was 1 article of occipital headache, 1 of neck pain, 1 of tarsal tunnel syndrome, 1 of angioma and 1 of hiccup. In these 17 studies the ultrasound frequency range where mentioned, was 5-14 MHz.
Conclusion: This study provided basic data as reference for the design of more diversified and systematic clinical research in the domestic Oriental medicine community in the future.

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Introduction
Oriental medicine procedures such as acupuncture therapy and pharmacopuncture therapy are relatively safe and effective Oriental medicine treatments used with various methods, in various diseases. Interestingly, Oriental medicine procedures performed in high risk areas of the body may result in a risk of injuries being reported, particularly when insertion into a specific anatomical structure is performed. This limits performing Oriental medicine acupuncture by palpation with the hand or using needling sensation to determine the accurate location (de qi) for the treatment.

Ultrasound imaging diagnostic apparatus are very efficient equipment that can visualize the internal anatomical structure of the human body using a harmless, non-invasive method. As well as diagnosis of disease, ultrasound can be a very useful guide for accurate and safe procedure during acupuncture therapy [1]. However, it is not feasible for Oriental medicine doctors to use ultrasound machines routinely due to limited access, and typically their use is restricted to needle therapy, electroacupuncture, acupotomy, and pharmacopuncture.

Thus, this study analyzed clinical research that used ultrasound-guided Oriental medicine using needle therapy, electroacupuncture, acupotomy and pharmacopuncture, to examine the research trends, both domestically and in foreign countries.

Materials and Methods

Articles searches

Foreign articles were retrieved from PubMed and CNKI, whilst domestic articles were retrieved from NDSL (National Digital Science Library), KISS (Korean Studies Information Service System), and OASIS (Oriental Medicine Advanced Searching Integrated System). "Ultrasound" was combined with "The Oriental medicine acupuncture" to retrieve articles. The Oriental medicine acupuncture was limited to acupuncture, electroacupuncture, acupotomy, and pharmacopuncture. The search was performed using the Boolean operators "AND" and "OR", and a cross-search of "Patient and Intervention" was performed (Table 1). "Patient" was
showed that most articles were Chinese in origin, as previously reported (11), followed by 5 Korean articles and 1 article published in the US.

Study design analysis

The 17 selected articles were divided into case reports, case series, non-randomized controlled trial (nRCT) and randomized controlled trial (RCT). Three were case reports, 5 were case series, 1, was a nRCT, and 8 were RCTs (Table 2).

Diseases by study

Of the 17 articles classified by disease, there were 6 studies of omalgia; 4 of knee pain; and 2 of peroneal nerve palsy. In addition, there was 1 article on occipital headache, 1 on neck pain, 1 on...
<table>
<thead>
<tr>
<th>Author (y)</th>
<th>Study type</th>
<th>Object</th>
<th>Treatment Group/Control Group</th>
<th>Treatment site</th>
<th>Ultrasound Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kim SH [4] (2011)</td>
<td>Case report</td>
<td>Peroneal nerve palsy</td>
<td>$n = 1$, General oriental medicine therapy (acupuncture, pharmacopuncture, cupping, herbal medicine) and acupotomy</td>
<td>Superior nuchal line, cervical spinal processes, levator scapula attachment site</td>
<td>NR</td>
</tr>
<tr>
<td>Park MY [5] (2011)</td>
<td>Case series</td>
<td>Posterior headache</td>
<td>$n = 2$, Acupuncture, herbal medicine and ultrasound-guided acupotomy</td>
<td>0.5 cm behind and 0.5 cm below the Yangneungcheon (GB34)</td>
<td>NR</td>
</tr>
<tr>
<td>Kim SH [6] (2012)</td>
<td>Case series</td>
<td>Peroneal nerve palsy</td>
<td>$n = 3$, General oriental medicine therapy (acupuncture, pharmacopuncture, moxibustion, cupping, physical therapy, herbal medication) and acupotomy</td>
<td>Superior nuchal line, cervical spinal processes, levator scapula attachment site</td>
<td>NR</td>
</tr>
<tr>
<td>Guo Q [8] (2013)</td>
<td>nRCT</td>
<td>Periarthritis humeroscapularis</td>
<td>T: $n = 30$, Small-needle-knife therapy under ultrasonography guidance&lt;br&gt;C: $n = 30$, Small-needle-knife therapy</td>
<td>Coracobrachialis, biceps brachii short head, supraspinous muscle, infraspinous muscle, teres minor</td>
<td>12.5 MHz</td>
</tr>
<tr>
<td>Roy [9] (2013)</td>
<td>Case report</td>
<td>Supraspinatus tendinopathy</td>
<td>$n = 1$, Dry needling</td>
<td>Supraspinatus tendon</td>
<td>7-13 MHz</td>
</tr>
<tr>
<td>Liang HY [12] (2016)</td>
<td>RCT</td>
<td>scapulothoracic periartthritis</td>
<td>T: $n = 115$, Knife acupuncture therapy guided with high-frequency ultrasound&lt;br&gt;C: $n = 109$, Knife acupuncture therapy without high-frequency ultrasound</td>
<td>Supraspinous muscle, infraspinous muscle, teres minor</td>
<td>5-12 MHz</td>
</tr>
<tr>
<td>Jeong JK [13] (2016)</td>
<td>Case series</td>
<td>Rotator cuff Disease</td>
<td>$n = 4$, Ultrasound-guided Bee Venom pharmacopuncture combined with integrative Korean Medicine treatment (acupuncture, herbal medicine, physical therapy)</td>
<td>Gyeoung (LI15), Byeonggung (SI12), Gogwon (SI13), Gyeondyo (TE14), Cheonjung (SI11), Nosu (SI10), Gyeonejung (SD09), Unnum (LU02), Nohoe (TE13)</td>
<td>NR</td>
</tr>
<tr>
<td>Li M [14] (2017)</td>
<td>RCT</td>
<td>Knee osteoarthritis</td>
<td>T: $n = 28$, Ultrasound guided needle knife&lt;br&gt;C: $n = 27$, Needle knife</td>
<td>Medial &amp; lateral collateral ligament, patellar tendon, medial&amp;lateral patellar retinaculum, ITB, suprapatellar bursa, quadriiceps femoris tendon, suprapatellar bursa</td>
<td>7-12 MHz</td>
</tr>
<tr>
<td>Liu Y [18] (2018)</td>
<td>RCT</td>
<td>Intractable hiccup</td>
<td>T: $n = 15$, Ultrasound guided acupuncture&lt;br&gt;C: $n = 15$, Acupuncture</td>
<td>Gyeoksu (BL17), Joksamni (ST36)</td>
<td>NR</td>
</tr>
</tbody>
</table>

C, control group; nRCT, non-randomized controlled trial; NR, not reported; RCT, randomized controlled trial; T, treatment group.
place. Ultrasound imaging is made by detecting an echo reflected in the body tissue or on the interface, and the relative intensity of the reflected sound wave is displayed as the relative brightness of pixels in an image. Ultrasound imaging collects the direction of progress of this sound wave, the time of return after reflection and the echo intensity, and shows them as an image.

Medical ultrasound visualizes muscles, tendons and many internal organs, and their size, structure and pathological damage with a real-time tomographic scan, which provides diagnostic medical imaging [19]. Medical ultrasound measures the reflected wave returning from the interface of tissues using ultrasound frequencies at 1-10 MHz, which is a nondestructive and non-invasive process that allows procedures to be safely performed by locating blood vessels or nerves during acupressure treatments [5]. However, compared to the routine use ultrasound technology in Western medicine, ultrasound has not been widely used in Oriental medicine as studies are based on a theory of anatomical connectivity through the meridian systems and meridian muscles. In addition, Oriental medicine doctors find it difficult to approach the use of ultrasound technology due to accessibility in the clinic compared to Western medicine where ultrasound machines are readily available. This is despite the fact that ultrasound can show visible results throughout the process of patient treatment, and allow comparisons of before and after images. Subsequently, if ultrasound studies based on anatomical theory continue, it would be possible to visualize Oriental medicine therapy in progress. Internal diseases as well as several musculoskeletal diseases treated by Oriental medicine may be performed to a higher quality through ultrasound visualization.

The aim of this study was to understand the current research directions in ultrasound-guided Oriental medicine acupuncture, both at home and abroad through searching databases (PubMed, CNKI, KISS, NDSL, and OASIS) for clinical research on Oriental medicine acupressure using ultrasound. The 17 selected articles were classified by treatment method. Of the 17 articles, most were studies that performed acupotomy therapy, followed by 3 studies that performed acupuncture therapy, 2 studies that performed pharmacopuncture therapy, and 1 study that performed electroacupuncture therapy (Table 5).

### Treatment method by study

The 17 selected articles were classified by treatment method. Of the 17 articles, most were studies that performed acupotomy therapy, followed by 3 studies that performed acupuncture therapy, 2 studies that performed pharmacopuncture therapy, and 1 study that performed electroacupuncture therapy (Table 5).

### Ultrasound frequency by study

Analysis of the frequency of ultrasound used in the 17 selected studies showed an ultrasound frequency range of 5-14 MHz was used, and there were differences within this range according to the study. The frequency ranges were 5-10 MHz, 5-12 MHz, 7.5 MHz, 7-12 MHz, 7-13 MHz, 9-14 MHz and 12.5 MHz. In 10 articles the frequency was not mentioned.

### Discussion

Ultrasound is a sound wave with elasticity, and there is a mechanical interrelationship between this and the body. In the sound wave, a wave is produced along the route of progress, and since energy decreases with distraction and heat, diminution takes place. Ultrasound imaging is made by detecting an echo reflected in the body tissue or on the interface, and the relative intensity of the reflected sound wave is displayed as the relative brightness of pixels in an image. Ultrasound imaging collects the direction of progress of this sound wave, the time of return after reflection and the echo intensity, and shows them as an image.

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Thus, the aim of this study was to understand the current research directions in ultrasound-guided Oriental medicine acupuncture, both at home and abroad through searching databases (PubMed, CNKI, KISS, NDSL, and OASIS) for clinical research on Oriental medicine acupressure using ultrasound.

The 17 selected articles were analyzed, and showed that research began to be published in China in 2004. Studies have consistently been published each subsequent year showing that there has been an increasing interest in ultrasound-guided procedures. Most studies were published in China, followed by 5 in Korea and one in the US, and since ultrasound was the first phase of search terms used, it was not surprising that most articles selected for this study were RCTs. There have been no studies published in Korea and
the US since 2016, while studies have been published in China up until 2018. When the selected articles were analyzed by condition the most common was omalgia studies (6 articles), followed by knee pain (4 articles). Generally, ultrasound guidance was used to accurately locate, aiding the procedure to avoid side-effects like pneumothorax. The treatment method most commonly used was acupotomy therapy (11 articles) indicating that this therapy requires more accuracy and safety in procedures with deeper and broader regions and benefits from ultrasound guidance.

The range of frequencies of ultrasound in the studies was usually between 5-14 MHz. The range differed depending on the study, but it was found that usually, the ultrasound frequency was between 5-15 MHz to observe musculoskeletal systems or superficial organs whilst a frequency of between 3.5-5 MHz was used to observe abdominal organs. There were 10 articles that did not mention the frequency. Liu et al [18], who performed abdominal ultrasound, did not mention the frequency. To develop accurate methodology the ultrasound frequency used in studies should be published for the reproducibility of research.

Lee [20] observed a safe needling depth and morphological structure of the acupuncture points around the shoulder joint using musculoskeletal system ultrasound, while Kim et al [21] explored the reliability of ultrasound as a system to evaluate safe needling depths for abdominal acupoints and checked reproducibility of ultrasound and secure accuracy and safety of Oriental medicine community to take more interest in it and conduct more studies. It is judged that it would be necessary to conduct studies utilizing various Oriental medicine interventions and research related to ultrasound that can be applied to domestic clinical practice in the future. This study would provide basic data for the design of more diversified and systematic clinical research by the domestic Oriental medicine community in the future.

Ultrasound is an auxiliary medical device used in various noninvasive procedures as well as for diagnostic purposes. This study has highlighted the fact that it is necessary to continue to conduct studies that broaden the range of applications of ultrasound and secure accuracy and safety of Oriental medicine acupuncture.

Conflicts of Interest

The authors have no conflicts of interest to declare.

Acknowledgments

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