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Original Article

Ultrasound-guided technology versus neurostimulation for sciatic nerver block: a meta-analysis

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Abstract: Background: Sciatic nerve block is widely used for anesthesia and analgesia in lower limb surgery, traditional method used for sciatic nerve block is nerve stimulation guidance. Whether the use of ultrasound-guided technology can increases the success rate of sciatic nerve block and provide other benefits are not defined. This meta-analysis was aimed to clarify this issue. Method: We searched Pubmed, the Cochrane library and Google Scholar. A total of 10 RCTs met our inclusion criteria. The patients included underwent ultrasound-guided or nerve stimulation guidance for sciatic nerve block. We compared the success rate, vascular puncture, the time of procedure and Success rate of catheter placement. Results: Ultrasound-guided technology, compared with nerve stimulation for sciatic nerve block, provided higher success rate. [RR = 1.22 95% CI: 1.04-1.42, P = 0.01], Ultrasound guidance also reduce the risk of vascular puncture. [RR = 0.13 95% CI: 0.02-0.97, P = 0.05]. However, the success rate of catheter placement [RR = 1.1095% CI: 0.93-1.29, P = 0.27] and the time of performing sciatica never block [RR = -0.17 95% CI: -1.61-1.27, P = 0.82] did not differ significantly. Conclusions: Compared to traditional nerve stimulation guidance, ultrasound guidance for sciatic nerve may improve the success rate of block and reduce the risk of vascular puncture.

Keywords: Sciatic never block, ultrasound-guided technology, meta-analysis

Introduction

The use of ultrasound guidance has provided an opportunity to perform many peripheral nerve blocks that used to be difficult to perform with other techniques, and has got more and more popular over the past decade. In recent years, the ultrasound technology has been used for peripheral nerve blocks for many types of peripheral nerve blocks in both adults and children [1-9]. Some reviews and meta analyses demonstrated that ultrasound-guided peripheral nerve block may offer many benefit including a higher success rate, shorter time to onset of blocks, and possibly better quality of sensory block [10-15]. In clinical practice, sciatic nerve block is widely used for anesthesia and analgesia in lower limb surgery. Traditional method used for sciatic nerve block is nerve stimulation guidance [16, 17]. Since ultrasound technology can offer accurate localization of the nerve and the distribution of local anesthetic, it has been introduced to sciatic nerve block and perineural catheters. While, whether the use of ultrasound-guided can improve success rate of sciatic nerve block remains controversial. Some previous literatures confirmed that ultrasound-guided for sciatic nerve block handsome advantages compared to nerve stimulation, such as improved block success rate, reduced the dose of local anesthetics and so on [18-20]. Several randomized controlled trials (RCTs) have been conducted to evaluate the efficiency of ultrasound guided technology for sciatic nerve. However, the number of patients in each study was too small to provide enough statistic power. We sought to clarify this issue by identifying all eligible RCTs that compared these two techniques.

Methods

Data extraction and quality assessment

Two reviewers searched PubMed, the Cochrane library and the Google Scholar databases for

Table 1. Characteristics of included studies

Author (year published)	Study population	Local anesthetic	success blocks (US/PNS)	Other reported outcomes (US/PNS)	Jadad score (1-5)
Bendtsen, Thomas F. 2011	M/F adults	Ropiv 0.75% 30 ml	47/38	Success catheter placement: 50/48	5
Maalouf, D. 2012	M/F adults	Bupiv 0.5% 30 ml + epineph 30 ml	24/21	Success catheter placement: 24/21	5
Dufour, E. 2008	M/F adults	Ebupiv 0.5% 20 ml	17*/4	Mean time to perform block (min): 5.1/4.4	5
van Geffen, G.J. 2009	M/F adults	1.5% + adrenaline	20/15	Mean time to perform block (min): 6/7.6	4
Mariano, E.R. 2010	M/F adults	Mepiv 1.5% + epineph 2.5-5.0 ug/ml 40 ml	38/27	Vascular puncture: 0/5; Success catheter placement: 39/31	4
Danelli, G. 2009	M/F adults	Ropiv 0.75% 20 ml	22/18	NR	4
Mariano, E.R. 2009	M/F adults	Mepiv 1.5% + epineph 2.5-5.0 ug/ml 40 ml	20/16	Vascular puncture: 0/2; Success catheter placement: 20/16	4
Perlas, A. 2008	M/F adults	Lido 2% 15 ml + 1:200K	33/20	Mean time to perform block (min): 8.1/8.3	5
Sala-Blanch, X. 2012	M/F adults	Mepiv 1.5% 20 ml	25/26	NR	4
Domingo-Triado, V. 2007	M/F adults	Ropiv 0.5% 35 ml	29*/28	NR	5

US = ultrasound guided, ES = electrical never stimulation, Nerve stim = nerve stimulation, F = female, M = male, N = number of the subjects, Ropiv = ropivacaine, Bupiv = bupivacaine, epineph = epinephrine, mepiv = mepivacaine, * = the sciatic never in US group was blocked by ultrasound and never stimulation, lebupiv = lebupivacaine.

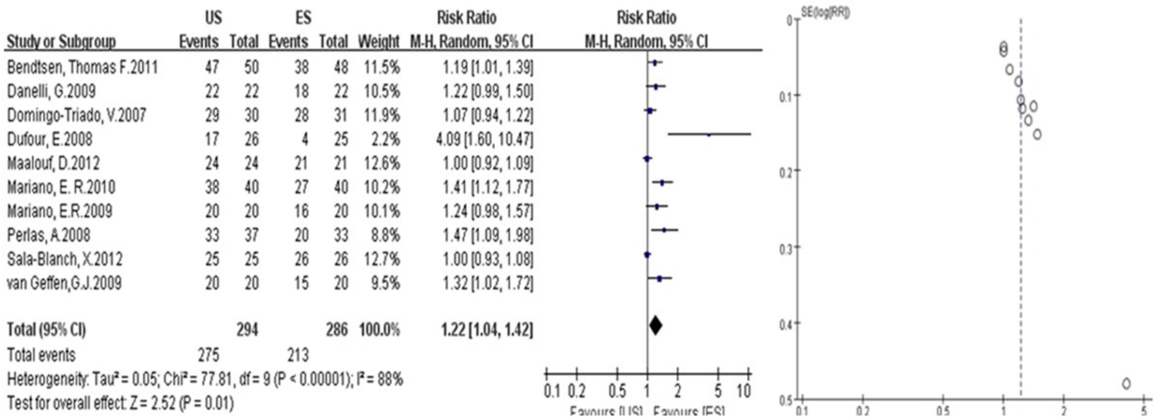

Figure 1. Block success rate [RR = 1.22 (95% CI: 1.04-1.42), P = 0.01]. US = ultrasound guided, ES = electrical never stimulation, events = number of patients who had a successful nerve block, total = number of patients included in each study.

the time period January 1, 1990 to march 31, 2013 independently. The key words for our investigation are ultrasound and sciatic. During databases searching, we restricted articles type to "clinical trials" and "randomized controlled trials (RCTs)", subjects to "human", and language to "English".

Two reviewers primarily screened titles, abstracts, and keywords of citations from electronic databases. The irrelevant articles were excluded, then we obtained the full-text articles of all relevant studies and the authors assessed whether they met the inclusion criteria (randomized controlled trials, prospective data collection, English language, comparison of US and PNS guidance for sciatic nerve blocks in humans).

Methodological quality of included RCTs were assessed by Jadad score and low quality literatures were excluded .Any discrepancy was settled by discussion with a third author (Li) until consensus was reached. No minimum sample sizes were invoked for inclusion of studies. Because of anatomy and physiology differences between children and adults, we excluded any trials that studied on children. Owing to the different standards of success, we collect data according the definition in the original literatures. Relevant data included the authors, the year of publication, the subjects US versus ES, the local anesthetic, the control group, the number of success of block and catheter placemen, the vascular puncture, the procedure time. We extracted the outcome measures to a spread sheet.

Statistical analysis

For binary outcomes such as block success, the number of vascular puncture, a pooled risk ratio (RR) was estimated using the fixed-effect Mantel-Haenszel method when the between-study heterogeneity was not significant, if *P*-value of chi-square test was greater than 0.10 or I^2 less than 50%. If significant heterogeneity present, the DerSimonian-Laird [21] random effects model was used. Further analysis was planned a priori to explore relevant heterogeneity, Sensitivity analysis was performed by omitting one study each time and investigating the influence of a single study on the overall pooled estimate. Publication bias was assessed by visually inspecting funnel plots. However, we were not able to create funnel plots if the small of trails were included in our meta-analysis .For continuous outcomes such as procedure time, we calculated from each study and combined using the DerSimonian-Laird random effects model to account for difference among studies [22]. All statistical analyses, including assessment of heterogeneity, were performed with RevMan Version 5.2 (RevMan 5.2, The Cochrane Collaboration, Oxford, United Kingdom). The level of significance for all tests was set at P<0.05.

Results

A total of 418 studies were identified by our search, of which 10 met all inclusion criteria. 408 articles were rejected for the following reasons: 374 studies were not RCTs, 2 studies used for children, 20 cases did not compare ultrasound versus control, 5 studies assessed

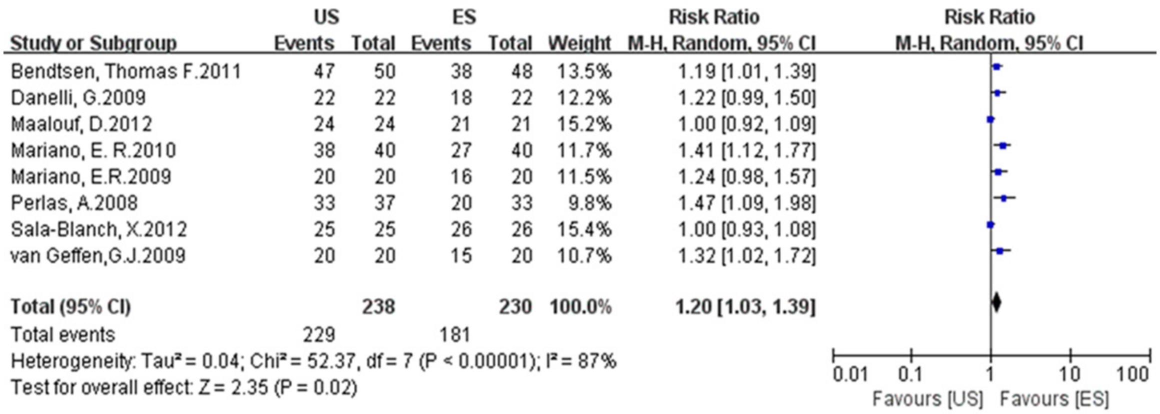

Figure 2. Block success rate. [RR = 1.20 (95% CI: 1.03-1.39), P = 0.02]. US = ultrasound guided, ES = electrical never stimulation.

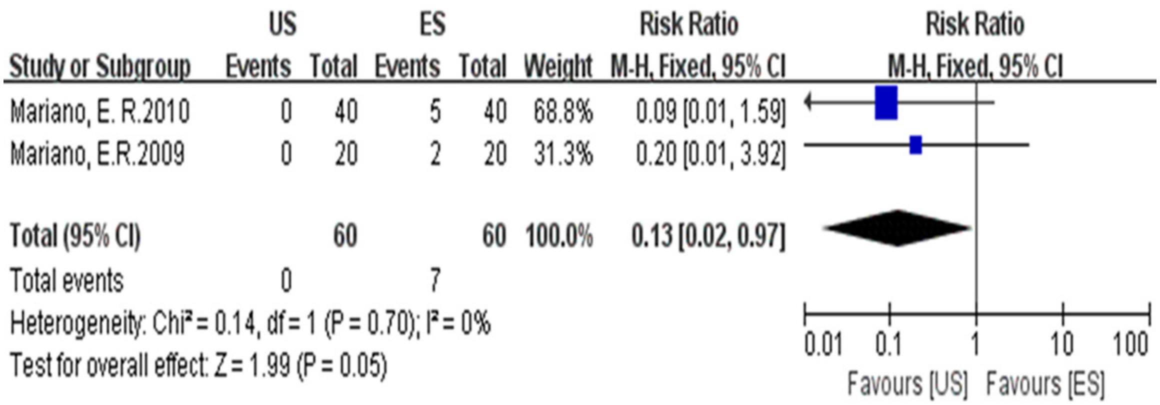

Figure 3. Vascular puncture during block performance.

ultrasound-guided femoral nerve block, 1 study evaluated the cost-effectiveness between the two groups, 3 studies were outside the scope of this meta-analysis (e.g. US-guided for sclerotherapy treatment of venous malformation ,examination in the surgical treatment of lower extremity peripheral never injuries and effect on femoral arterial blood flow), 3 studies evaluated the minimum effective anesthetic volume between ultrasound guidance and nerve stimulation guidance. There were 580 subjects included in the 10 randomized trials. Details of these included studies are summarized in **Table 1**.

Success rate of block

The combine RR from eligible studies showed the success rate in the US group was 1.22 times higher than that of the PNS group [RR 1.22, 95% confidence interval (CI) 1.04-1.42, P = 0.01] (**Figure 1**). But there was significant heterogeneity among studies [P<0.00001); I^2 = 88%]. In order to get a more accurate conclusion, We ruled out two studies which compared blocks performed using both US and PNS to blocks done with PNS guidance alone. However, the result was still significant [RR 1.20, 95% CI 1.03-1.39, P = 0.02] (**Figure 2**). At the same time, significant heterogeneity among studies was still existed [P<0.00001); I^2=87%]. Sensitivity analysis was performed by omitting one study each time, the pooled result was still significant (*P*<0.05). Our meta-analysis' funnel plots appear slightly asymmetrical (**Figure 1**). Therefore, in evaluating our funnel plots, there may be publication bias.

Vascular puncture

Since the anesthesiologists operating the blocks were experienced in the technology,

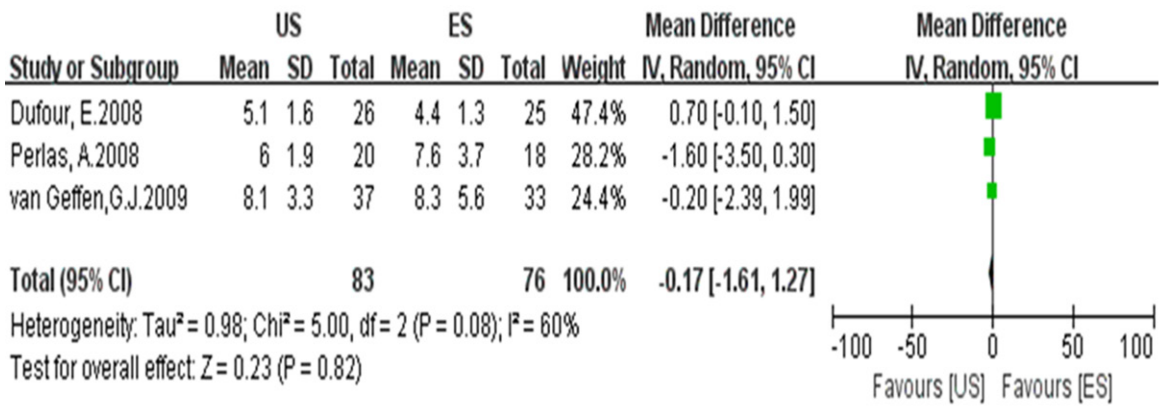

Figure 4. Procedure time (in minutes).

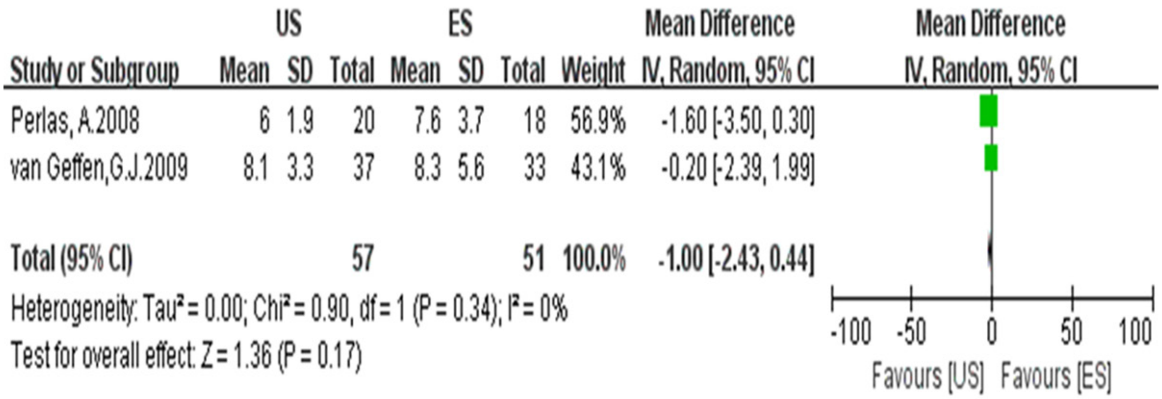

Figure 5. Procedure time (in minutes) except E2008).

there was no serious complications such as systemic local anaesthetic toxicity, permanent neurological damage reported by any of the studies included. The normal complication specifically assessed was vascular puncture. Only several studies compared vascular puncture between the US and PNS groups. The incidence of vascular puncture showed a statistical difference between the US and PNS groups [RR 0.13, 95% CI 0.02-0.97, P = 0.05)] (**Figure 3**). No heterogeneity was detected among studies [P = 0.70); I^2 = 0%].

Procedure time

The time to perform blocks using ultrasound guidance and never stimulator was studied in several studies. The time used for performing sciatica never was expressed with median time and different range in some studies. Some were expressed with mean time and standard deviation. For lack of raw data in these studies, we cannot calculate the mean time and standard deviation from these studies mentioned. So these literatures were ruled out. The US and PNS groups had no difference in procedure time [95% CI-1.61-1.27, P = 0.82] (**Figure 4**). Test of heterogeneity was significant among studies [P<0.0.08); I^2 = 60%]. We ruled out one study which compared sciatic never block performed using both US and PNS to blocks done with PNS guidance alone. But the result was not changed significantly [RR-1.00, 95% CI-2.43-0.44, P = 0.17] (**Figure 5**) No obvious heterogeneity was detected among studies [P = 0.34); I^2 = 0%].

Success rate of catheter placement

Popliteal-sciatic perineural catheter using ultrasound guidance versus electrical stimulation technique was mentioned in four studies. The combined result suggested that there was no difference between US and PNS [RR = 1.10,

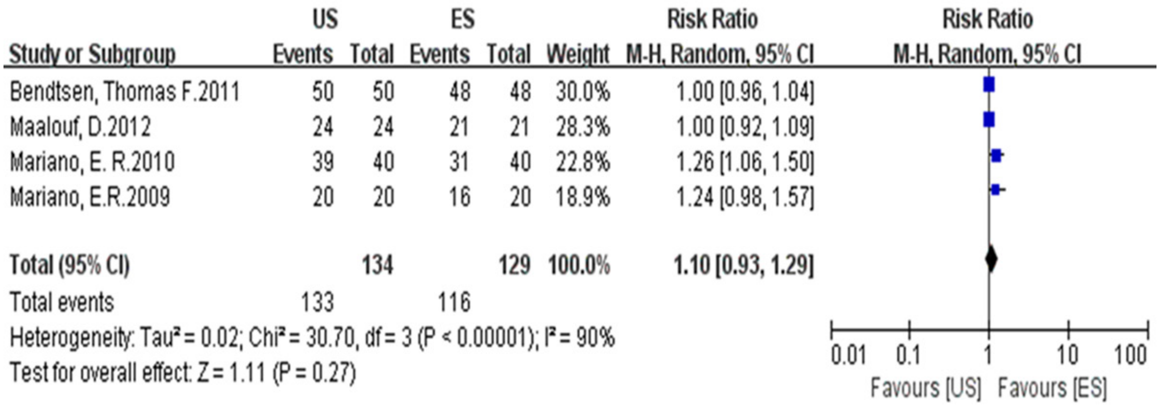

Figure 6. Sciatic perineural catheter insertion.

95% CI 0.93-1.29, P = 0.27)] (**Figure 6**). heterogeneity was significant among studies [P< 0.00001); I^2 = 90%].

Discussion

To our best knowledge, this is the first meta-analysis of studies of Ultrasound-guided technology versus neurostimulation for sciatic never block. Based on the comparison our results suggest that a significant increase in the overall success rate for sciatic nerve blocks performed by ultrasound-guided technique versus neroustimulator. However, at the time of this analysis, the result was influenced by significant heterogeneity and the results should be therefore interpreted with caution. Furthermore, there are other advantages of ultrasound-guided technique such as reduced rate of vascular puncture. However, the success rate of sciatic perineural catheter and time needed for block performance did not significantly differ between the two groups. Due to few studies published, the results were based on a small number of studies, interpretation of the results is warranted careful.

US guidance is currently believed to be the 'gold standard' for single-shot regional anaesthesia [31]. Recent meta-analyses have suggested that US-guided peripheral nerve catheter placement is associated with a higher success rate and a lower risk for accidental vascular puncture compared with NS guidance [32, 33]. Meanwhile, our meta-analysis demonstrated US can improve sciatic never block success rates, and reduced rate of vascular puncture .From our point of view, US is one of the most helpful and appropriate technique that anaesthetists can select for performing sciatic never block making the block easier to perform, more effective, and safer.

There are several limitations of our meta-analysis. First of all, the number of random controlled trials (RCTs) was small and the number of subjects for our analysis was also relatively small, with many studies including <50 subjects in each group. Secondly, the related literatures about children were excluded for the differences of anatomy and physiology additionally, the definition of "success" were inconsistent (at 15 min, at 30 min, catheter inserted and so on), which may lead to biased results, we collected data following the standards of the original literature. In addition, there was significant heterogeneity among the included literatures. the heterogeneity may contributed by the approach of sciatic nerve block (Lateral Midfemoral, Popliteal, Subgluteal Approach), types of local anesthetic (ropivacaine, bupivacaine, mepivacaine and so on), the dose of local anesthetic (different volumes), the number of injection (single injection and multiple injections) and so on.

In summary, Compared to traditional nerve stimulation guidance, ultrasound guidance for sciatic nerve may improve the success rate of block and reduce the risk of vascular puncture. However, the success rate of catheter insertion and time needed for block performance did not differ significantly between the two groups. More clinical trials are needed to confirm these conclusions.

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