European Review for Medical and Pharmacological Sciences 2022; 26: 471-484

Efficacy of regional anesthesia using ankle block in ankle and foot surgeries: a systematic review

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Abstract. – Ankle blocks are commonly used as surgical anesthetics and for postoperative analgesia during foot surgeries. It is chiefly an infiltration block which utilizes a localized anesthetic approach for providing surgical anaesthesia for a variety of foot procedures. Thus, in this systematic review, we focus primarily on the use, effectiveness, success and failures of regional ankle blocks in outpatient surgeries and hereby compare them with other anesthetic techniques and agents commonly used. Literature search was carried out using PubMed, Medline, Embase, Scopus and Cochrane Library for the studies existing till April 2021. Search was conducted by two independent reviewers separately keeping in view the structured format of the review. Data were thoroughly read and were extracted manually into a structured data extraction form. After going through the databases, 252 relevant articles were identified as per the search strategy. Among those 99 duplicate records were taken away. Among the remaining one hundred fifty-three records, one hundred thirty-eight records were excluded majorly going through their titles and abstracts. Next matching our inclusion criteria and going through the full texts, fifteen studies were excluded. Lastly, after excluding the reviews and case studies we included relevant 11 studies that compared the efficacy of ankle block in outpatient foot and ankle surgery in the present analysis. Seven studies used anatomic landmark guided (ALG) approach, three studies used ultrasound guided (USG) approach, while one study included both approaches. The results showed a significantly lower VAS score postoperatively at 24 hrs. It was observed that in general, immediately after surgery the VAS pain scores are low due to the continued analgesic effect provided by the ankle block. 0.25%-0.5% bupivacaine was the most common single long-acting local anesthetics used. Patient satisfaction ranged from 66%-95.8%. Major complications included block failure and consequent requirement of general anesthesia and few cases of transient nerve injuries. Therefore, this systematic review supports the fact that ankle block has advantages like excellent success rates with minimal side effects, high levels of patient satisfaction and decreased hospital expenses. Thus, it proves to be a safe and highly effective means of regional anesthesia for the majority of foot and ankle surgeries in outpatient settings.

Key Words:
Regional anesthesia, Ankle block, Postoperative pain, Management, Efficacy.

Introduction

Ankle and foot surgeries are usually considered as painful procedures postoperatively. In today's world, regional anesthesia for ankle and foot surgeries is the preferred method as they provide both good anesthesia and postoperative analgesia. Its application has become more common in daycare or outpatient procedures[1].

Regional anesthesia has several advantages, including effective control of postoperative pain, reduction in pain scores, decreased use of sedatives and opiates, evasion of side effects like nausea, vomiting, and drowsiness associated with using general anesthesia, improved sleep, decrease in length of stay in the hospital, reducing hospital expenses and overall helps in improving patient satisfaction scores[2,3].

Ankle blocks are commonly used as a surgical anesthetic and for postoperative analgesia during foot surgeries. It is chiefly an infiltration block that utilizes a localized anesthetic approach for providing surgical anesthesia for a variety of foot procedures. The application of this technique is not cumbersome as it does not require any special equipment. It depends on anatomic landmarks that are easily identified without difficulty.

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The ankle block utilizes five injections that anesthetize five different nerves: two deep and three superficial. Among the deep nerves, one is the tibial nerve, and the other one is the deep peroneal nerve; the three deep nerves included the superficial peroneal nerve, the sural nerve, and the saphenous nerve. This block causes leg ambulation on the affected side, but to a lesser extent in comparison to the sciatic and popliteal blocks. In adjunct to this block, the use of long-acting local anesthetics may offer the best analgesia postoperatively[4]. Hence, the advantages of ankle block include technical ease, excellent success rates with minimal side effects, and easy technique-wise[5-7].

Ankle block can be indicated for a variety of foot procedures like forefoot reconstruction in outpatient surgeries, osteotomy, bunionectomy, relief fracture pains, and analgesia for soft tissue injuries. Furthermore, it also plays an important role in diagnostics and therapeutics. The contraindications for its use include patients with infection, edema, trauma of the soft tissues, scarring of the block placement area, and patient refusal.

Ankle blocks have conventionally been carried out by identifying nerves using anatomic landmarks. The effectiveness and performance of ankle blocks using the anatomic guided landmark (AGL) technique are mixed. This can be attributable to a range of factors, including associated technique factors, patient demographics variances, and the type and amount of local anesthetics used. Recently to overcome this, ultrasound-guided (USG) imaging is being included in these procedures. With the use of advanced USG technology, considerable progress has occurred, which includes: ease for the anaesthesiologist's inaccurate identification of the nerves along with its branches, easy monitoring of the anesthetic flow during injection, speeding up of the onset time for the block, better success rates due to constant blockade although with the less amount of anaesthetics[8,9].

Since there is paucity in literature regarding the good quality outcome studies focusing primarily on the use, effectiveness, success, and failures of regional ankle blocks in outpatient surgeries and hereby comparing them with other anesthetic techniques and agents commonly used. Therefore, this systematic review aimed to investigate the prospective and retrospective studies pertaining to regional ankle block in foot and ankle outpatient surgery.

Materials and Methods

Search of Literature and Strategy

The present systematic review was accomplished in agreement with the guidelines framed by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The database search was carried out using PubMed, Medline, Embase, Scopus, and Cochrane Library for the studies existing from the initial records till April 2021, in context to the randomized controlled trials (RCTs) that authenticated the effectiveness and safety of regional anesthesia using ankle block in outpatient foot and ankle surgery. This intended search was conducted by two independent reviewers, keeping in observation the structured format of this systematic analysis.

Intervention

Our search strategy incorporated the terms "regional anesthesia", "foot and ankle surgery", "ankle surgery" "ankle block", "advancement ankle surgery" and "ultrasound-guided ankle bock".

Study Design

This systematic review enrolled all RCT studies and observational studies which underwent foot and ankle surgery using specifically ankle block and ultrasound-guided ankle blocks and which primarily focused on the efficacy of the above-stated interventions.

Inclusion Criteria

In this review, we included all published studies from the last 15 years, i.e., ranging from the year 2005 to the year 2021 (search was conducted on 28/5/2021).

Studies in the English language and academic peer-reviewed journals were included.

All studies included in this analysis met the PICOS criteria (population, intervention, comparator, outcomes, study design):

- Population: included patients who underwent outpatient foot and ankle surgery.
- Intervention: Using ankle nerve block as a method of pain control.
- Comparator: Single-injection ankle nerve block.
- Outcomes: Visual analog scale (VAS) at various time intervals, effectiveness, oral analgesics used in terms of amount for pain management, overall patient satisfaction, and hospital

admission required or not. Further, it was made sure that included studies had a follow-up rate of at least 80% cases.

- Study design: Interventional RCTs.

Exclusion Criteria

Studies were published in a language other than English.

Studies that utilized techniques other than the desired one were excluded.

Studies including comparative cohort studies, case reports or series, and articles based on basic science were also excluded from this review.

Process of Screening and Selection of Articles

All the published research articles that met our inclusion and exclusion criteria were assessed. The selected entire articles were reviewed and screened by the two independent researchers. Additionally, all the selected articles, bibliographies were also reviewed thoroughly in an attempt to obtain some more relevant researches which were not detected during the initial research. Thereafter any obtained discrepancy between the two researchers was resolved by discussion, and mutual consent was obtained from both.

Ethical clearance from the institutional Ethical Committee was not required as all the obtained data were extracted from studies that had already been published earlier. We did not receive any outside funding for the execution of this study.

A "PRISMA flow chart" has been presented which evidently represents the screening process in the present review (**Supplementary Figure 1**).

Data Extraction and Assessment

The data was cautiously read and manually extracted from the included studies using a standardized data extraction method. The following information was gathered: authors and year of study, study design, study groups, type of block used, approach for anesthesia, type of analgesic regimen used for infiltration, the patient-related outcome in relation to pain evaluation, amount of oral analgesics, complications and overall patient satisfaction.

Results

After going through the databases, 252 relevant articles were identified as per the search strategy. Among those 99 duplicate records were taken away. Among the remaining one hundred fifty-three records, one hundred thirty-eight records were excluded, majorly going through their titles and abstracts. Next, matching our inclusion criteria and going through the full texts, fifteen studies were excluded. Lastly, after excluding the reviews and case studies, we included relevant 11 studies that compared the efficacy of ankle block in outpatient foot and ankle surgery in the present analysis (**Supplementary Figure 1**). All the included studies were published between the year 2005-2021. Among these 9 studies were designed as prospective comparative studies[10,11,13-15,17-20], among which 6 studies were RCTs[11,14,17-20]; while 2 studies were retrospective comparative studies[12,16]. Table I summarizes the included studies and their patient baseline characteristics.

The Approach Used for Ankle Block

Seven studies used anatomic landmark guided (ALG) approach[10,11,13,15,16,19,20], three studies used ultrasound-guided (USG) approach[14,17,18] while one study included both the approaches[3]. Chin et al[12] concluded that in ankle block, US-guided tibial and deep peroneal nerve blockade improves its success rate in comparison to the conventional ALG technique, specifically in the hands of less-experienced practitioners.

VAS Pain Scores

Eight studies out of 11 included studies[11-16,19,20] evaluated pains using an ordinal visual analogue scale (VAS) of score 0 to 10 (score 0 indicated no pain while score 10 indicated maximum pain). The evaluation time of this score varied differently in these studies, ranging from immediately postoperatively, after 6 hrs, 12 hrs, 24 hrs, 48 hrs, at patient discharge, and during immediate follow-ups. The results showed a significantly lower VAS score postoperatively at 24 hrs. It was observed that, in general, immediately after surgery, the VAS pain scores are low due to the continued analgesic effect provided by the ankle block.

Combination of Ankle Blocks with Another Technique of Anesthesia

Ankle and foot surgeries are known for extreme postoperative pain. The ankle blocks are usually carried out preoperatively alone or in combination with other blocks or systemic analgesics or GA depth with the sole purpose of providing extended postoperative analgesia. Among the studies reviewed, authors used bilateral ankle

Table I. Study and patient characteristics.

S.no	Author	Year	Study design	Required surgery for	Study groups	Sample size	Mean age (years)	Gender (m;f)	Approach Used
1.	Rudkin et al[10]	2005	Prospective study	• Correction of lesser toe • Ostectomy of foot • Great toe nail procedure • Proximal osteotomy for bunion • Neuroma excision • Distal osteotomy for bunion • Removal of pins • Resection of soft tissue tumour	Bilateral ankle bocks	N=66	56 years	NA	Anatomic guided
2.	Samuel et al[11]	2008	Prospective, randomized, controlled single-blind study (RCT)	Forefoot surgery for soft-tissue and osseous procedures.	Gp 1: Ankle block Gp 2: Popliteal and ankle block	N=63 • Gp 1: 37 • Gp 2: 26	51.6 years	F:50 M:13	Anatomic guided
3.	Chin et al[12]	2011	Retrospective cohort study	• Forefoot • Midfoot • Hindfoot • Ankle	• Anatomic landmark guided (ALG) ankle block technique • Ultrasound guided (USG) ankle block technique. • 116: Bilateral ankle blocks (58 patients).	• 655 unilateral ankle blocks (655 patients)	NA	ALG (M/F): 37:84 USG (M/F): 153:365	Both: USG technique in 527 patients ALG technique in 128 patients
4.	Singh et al[13]	2013	Prospective randomized study	Forefoot reconstruction for Hallux Valgus	• Group A (n = 30) ankle block • Group B (n = 30) block before inflation of tourniquet	N=60	56.2 years	F:M=56:4	Anatomic guided
5.	Fredrickson et al[14]	2013	Prospective randomized placebo-controlled trials RCT.	• Forefoot • Ankle • Hind • Midfoot	• Ankle block (AB) and Sciatic Block (SB) • AB: (Dexa: 28; Placebo:32)	N= 126 • AB: 60 • SB: 66	AB:59 years SB:57 years	All Males	Ultrasound guided

Continued

Table I ***(Continued).*** Study and patient characteristics.

S.no	Author	Year	Study design	Required surgery for	Study groups	Sample size	Mean age (years)	Gender (m;f)	Approach Used
6.	Russell et al[15]	2014	Prospective study	• 1st Ray Osteotomy • Cheilectomy • Fusion • Neuroma • MTPJ replacement	Ankle block	N=81	56.6 years	NA	Anatomic guided
7.	Urfalioglu et al[16]	2015	Retrospective study	• Open wounds to the foot • Debridement • Toe amputation.	• Unilateral spinal block (Group S) (n=30) • Ankle block (Group A) (n=30).	N =60 Group A:30 Group S:30	Gp A: 49.03 years Gp S: 39.57 years	Gp A(F/M): 8/22 Gp S(F/M): 12/18	Anatomic guided
8.	Dawson	2016	Prospective RCT study	• Toe correction • Neuroma excision • Weil osteotomy • Cheilectomy	Ankle block: • Perineural (P) • Intravenous (IV) • None (N)	N= 90 Gp P:30 Gp IV: 30 Gp N:30	Gp P:63 Gp IV: 61 Gp N:62	Females: Gp P:24 Gp IV: 2 Gp N:29	Ultrasound guided
9.	Schipper et al18	2017	Prospective RCT study	Fore foot	• Ankle block (AB) • Single-shot popliteal fossa block (PFB)	Total= 167 AB: 79 PFB: 88	NA	NA	Ultrasound guided
10.	Kir et al[19]	2018	Prospective comparative study RCT	Hallux valgus surgery for forefoot	• General anesthesia (GA) • General anesthesia and ankle block (GA+AB)	N=60 GA:30 GA+AB:30	GA:4.7 Years GA+AB:47.6 years	NA	Anatomic guided
11.	Gwosdz et al[20]	2018	Prospective study, RCT	• Hammer toe correction • Hallux valgus correction • Midfoot osteotomy • Hindfoot osteotomy and arthrodesis, • Tendon repair and reconstruction.	• Gp A: ankle block before ankle tourniquet inflation with no incisional anesthetic. • GpB: ankle block immediately after ankle tourniquet inflation with no incisional anesthetic.	N=41 Gp A:12 Gp B: 14 Gp c: 15	NA	GpA (M/F): 3:9 Gp B(M/F): 5:9 Gp C (M/F): 6:9	Anatomic 3:9 guided

blocks[10], ankle block along with Popliteal fossa block[11,18], Ankle block (AB) and Sciatic Block (SB)[14], Unilateral spinal block[16], and in association with general anesthesia[19] (Table I).

Samuel et al[11] reported that a popliteal block in addition to an ankle block significantly increases postoperative pain relief following forefoot surgery. Similarly, Gwosdz et al[20] were of the observation that ankle block in combination with general anesthesia considerably diminished VAS and increased the American Orthopaedic Foot & Ankle Society (AOFAS) scores, reduced chronic postsurgical pain, decreased average length of hospital stay, and enhanced foot function both in early and 1-year postoperative periods. Also, Urfalioglu et al[16] reported ankle block to be a safe and efficient method in foot and ankle surgeries. They mentioned that various parameters like block formation times (BFT), times for being ready for operation (TBRFO), and the first analgesic need times (FANT) were comparatively longer in patients treated with ankle block in comparison to unilateral spinal block.

Single Long-Acting Local Anesthetics

The long-acting anesthetics used in the enrolled studies are listed in Table II. Choice of single long-acting local anesthetics or a combination like bupivacaine[12-16,18-20], lignocaine[10,12,15], levobupivacaine[11], or ropivacaine[10,17] is usually made to further make sure about the required prolonged analgesia. In this review, 0.25%-0.5% bupivacaine was the most common local anesthetics used. Rudkin et al[10] mentioned that Ropivacaine was found to be an efficient drug, chiefly with an additive like clonidine, to offer postoperative pain relief up to 17 hrs.

Patient Satisfaction Scale

Four studies in the present analysis recorded patient satisfaction ranging from 66%-95.8%[10,12,14,18]. However, in one of the studies, successful surgical anesthesia was more likely with the USG technique compared with the ALG technique (84% *vs.* 66%)[12]. One study by Fredrickson et al[14] utilized the NRS scale calculating for patient satisfaction. We cannot analyze the overall patient satisfaction scale used in these 4 studies as these scores were inconsistent.

Adverse Effects and Block Complications

All the adverse effects and block-related complications of the analyzed studies are listed in Table III. A major complication which included block failure and consequent requirement of general anesthesia was observed in 4 studies[12,14,17,18]; two studies reported nerve injuries[15,19]. However other complications included severe pain, pain in block site[10,14,17,18], residual numbness/tingling[14,18]. Inadequate blocks were easily corrected by further infiltration of local anesthetic by the surgeon around the surgical site.

Discussion

In this systematic review, we aimed at the efficacy of regional anesthesia using ankle nerve blocks in outpatients' foot and ankle surgeries. We included 11 studies in this analysis, and after analyzing them, the major insight drawn in our analysis depicted that a Regional ankle block is an effective and reliable method in controlling postoperative pain. With good patient acceptance, it can be routinely used in forefoot surgery as it provides the desired long-lasting postoperative analgesia. These findings are supported by the most recent scientific evidence available in this systematic review.

Gwosdz et al[20] mentioned that administration of regional ankle block in outpatient surgeries is a necessary step in providing suitable and effective pain management during the immediate postoperative period. The mechanism behind this is explained that an ankle block successfully hinders neural transmission from the surgical site towards the spinal cord and reduces CNS sensitization[20].

Going through the included literature, it was observed that regional ankle blocks are widely being used by the authors in various surgeries, which included surgeries of forefoot, midfoot, hindfoot, and ankle. Specific procedures like correction of the lesser toe, ostectomy of the foot, great toenail procedure, proximal osteotomy for a bunion, neuroma excision, distal osteotomy for a bunion, removal of pins[10], forefoot reconstruction for *hallux valgus*[13,19,20], open wounds to the foot and debridement[16], and tendon repair and reconstruction[20] were commonly encountered reasons for the administration of the regional ankle blocks.

Conventionally, regional ankle blocks were performed by depending on the anatomic landmarks for providing adequate block. Although various studies have reported success rates between 89% to 100%, still the anatomic landmark guided (ALG) technique is recognized as a difficult and unreliable one[21,22].

Table II. Details of drugs used and desired outcome.

S.no	Author	Year	Drug combinations used	Desired outcome
1.	Rudkin et al[10]	2005	50/50 mixture of lignocaine 1.5% plain and ropivacaine 7.5 mg/mL, ropivacaine 7.5 mg/mL alone or Ropivacaine 7.5 mg/mL and clonidine 1 g/kg.	• Determine patient acceptance of Bilateral AB • Examine the safety and efficacy of the three LA choices
2.	Samuel et al[11]	2008	20 mL of 0.25%.to 0.5% levobupivacaine.	• Compare the efficacy of a combined popliteal and ankle block with that of an ankle block alone in providing postoperative analgesia following forefoot surgery
3.	Chin et al[12]	2011	10 ml of local anesthetic (a 50:50 mixture of plain 2% lidocaine and 0.5% bupivacaine)	• Primary outcome: incidence of successful surgical anesthesia. • Secondary outcomes: admission and discharge pain scores in the PACU, the requirement for analgesia in the PACU, and the incidence of immediate complications of the ankle block.
4.	Singh et al[13]	2013	20 ml of 0.5% bupivacaine	• Timing of ankle block i.e. before or after inflation of tourniquet showed any difference in efficacy in postoperative pain control in first 24 h.
5.	Fredrickson et al[14]	2013	30 mL bupivacaine 0.5% to which 2 mL of study solution was added. Study solution: either dexamethasone 8 mg (2 mL dexamethasone DBL = dexamethasone sodium phosphate 8 mg, sodium citrate 10 mg, creatinine 8 mg)	• Primary outcome: proportion of patients reporting pain at 48 hours. • Patients reporting a numerical rating pain score (NRPS) greater than 2 (0-10) on emergence in the postanesthesia care unit (PACU) and the need for morphine rescue.
6.	Russell et al[15]	2014	1: 1 mixture of 2% lignocaine with 0.5% bupivacine	• Primary outcome: to analyse the safety, effectiveness and level of patient satisfaction following the first series of forefoot surgery performed under ankle block anaesthesia. • Secondary outcome: perceived benefits to the patient, prior to considering ankle block anaesthesia
7.	Urfalioglu et al[16]	2015	2 ml-5 ml of 0.5% bupivacaine	• To determine duration of anaesthesia, the time for being ready for operation (TBRFO) and the operation time. • The visual analogue scale (VAS) and first analgesic need time (FANT)
8.	Dawson et al[17]	2016	20 ml ropivacaine 0.75% containing dexamethasone 8 mg and 2 ml intravenous saline 0.9%. Ankle block with 20 ml ropivacaine 0.75% and 2 ml intravenous dexamethasone 8 mg; and an ankle block with 20 ml ropivacaine 0.75% and 2 ml intravenous saline 0.9%.	• To determine duration of return of sensation or movement; when sensation and movement were normal; pain scores on a visual analogue scale (0-10); • Analgesic use in the first seven days durations of blockade
9.	Schipper et al[18]	2017	50 Ml of 0.25% bupivacaine in equal amounts (10 mL)	• Primary outcome: conversion to general anesthesia from peripheral nerve block alone • Secondary outcome: measures included the visual analog scale (VAS), patient-perceived block effectiveness from 1 (not effective) to 5 (very effective), length of postanesthesia care unit (PACU) stay, and narcotic use in morphine equivalents.
10.	Kir et al[19]	2018	5 mL bupivacaine 0.5% after general anesthesia and tourniquet.	• Visual analog scale (VAS) and American Orthopedic Foot and Ankle Score (AOFAS) to assess the pain and foot function. • VAS and AOFAS were recorded at 3, 6, and 12 months during clinical visits.
11.	Gwosdz et al[20]	2018	20 mL of 0.25% bupivacaine	• To determine whether the timing of ankle block administration in relation to ankle tourniquet inflation has an effect on perceived pain and narcotic consumption using VAS scores at 24 hrs and 48 hrs.

Table III. Post-operative pain scoring and complications.

S.no	Author	Postoperative pain score	Satisfaction	Block failure/requirement of general anesthesia	Additional medication required	Others
1.	Rudkin et al[10]	NA	89% Success rate	NO	NO	Pain at torniquette site:1
2.	Samuel et al[11]	VAS score recovery room: 2.62 (none) VAS score after 6 hrs: 3.35 (mild) VAS score after 24 hrs: 4.30 (moderate) VAS score at discharge: 2.39 (mild)	96% of the patients in the combined-block group were satisfied or very satisfied. 76% of the patients in the ankle-block group were satisfied or very satisfied	NO	• 38% in the combined-block group required either codeine or morphine in addition to regular paracetamol • 59% additional anesthesia postoperatively	NO
3.	Chin et al[12]	At discharge absolute VAS pain scores: USG *vs* ALG: (0.3 *vs.* 0.7).	USG technique compared with the ALG technique (84% *vs.* 66%)	Unplanned GA required USG: ALG: (7 *vs.* 17%)	• Local anesthetic supplementation: USG < ALG (5% *vs.* 10%) • Supplemental fentanyl USG < ALG, (9% *vs.* 18% • Opioid analgesia ALG > USG	NO
4.	Singh et al[13]	Average VAS pain score at 4 h and 24 h was 2.5 and 4.5 in Group A and 3.9 and 6.3 in Group B respectively 95% patients at 4 h and 35% patients at 24 h in Group A did not require any oral Analgesia 70% patients at 4 h and 20% patients at 24 h in Group A did not require any oral Analgesia	NO	NO	NO	NO

Continued

Table III *(Continued)*. Post-operative pain scoring and complications.

S.no	Author	Postoperative pain score	Satisfaction	Block failure/requirement of general anesthesia	Additional medication required	Others
5.	Fredrickson et al[14]	At 24 hrs • DEXA: 10 (37%) • PLACEBO: 9 (31%) At 48 hrs: • DEXA: 13 (48%) • PLACEBO: 12 (41%)	NRS 10 (9-10) 10 (10-10)	3 cases	Tramadol required • DEXA:6 (23%) • PLACEBO: 5 (17%)	• Residual numbness/ tingling: D: 21 (78%); P: 21 (72%) • Severe pain: D: 2 (7%); P: 0 (0%)
6.	Russell et al[15]	Mean pain VAS score immediately after surgery was 0.4/10. Increase in reported pain levels over 12 h At 48 hrs mean pain scores decreased.	NO	NO	NO	NO
7.	Urfalioglu	VAS SCORE: GP A < GP S Post-operative 6th (hour): 0.33 Post-operative12th (hour): 2.67 Post-operative 24th (hour):1.20	NO	NO	NO	NO
8.	Dawson et al[17]	NA	NO	Gp P: 0/30 Gp IV: 5/30 Gp N:2/30	NO	Severe pain: Gp P: 4/30 Gp IV: 2/30 Gp N:5/30
9.	Schipper et al[18]	NA	Highly effective (AB : 4.79/5)	Conversion to GA: AB: 13.6% [12/88] PFB:12.7% [10/79]	PACU morphine requirements and doses were significantly reduced in the PFB group (*p* = .004) VAS significantly lower for the PFB patients	• Residual numbness/ tingling AB 2.3% [2/88] • Pain at block site: 6.9% (6/88)

Continued

Table III *(Continued)*. Post-operative pain scoring and complications.

S.no	Author	Postoperative pain score	Satisfaction	Block failure/requirement of general anesthesia	Additional medication required	Others
						• Analgesic effect remained: PFB > AB; AB 14.5 hours
10.	Kir et al[19]	The postoperative day 1 VAS score was significantly lower in the general anesthesia + ankle block group than in the general anesthesia group. (2.96 ± 0.71 *vs*. 1.3 ± 0.65, $p < 0.01$).	NO	NO	First need for postoperative analgesic was significantly longer in the general anesthesia + block group than in the general anesthesia group. (678.46 ± 92.32 *vs*. 64.33 ± 17.17 min)	NO
11.	Gwosdz et al[20]	At 24 hours after surgery, mean VAS scores groups A, B, and C were 5.3, 6.3, and 3.5 respectively. At 24 hours after surgery, mean VAS scores were 4.3, 4.9, and 2.8 respectively. At discharge:1.5, 1.0, and 2.0 respectively	NO	NO	No differences in the consumption of narcotics at 24 and 48 hours between groups in terms of morphine equivalents	NO

AB: Ankle block; PACU: post-anaesthesia care unit ;NRS: numerical rating scale; 0-10, 0 = no numbness/weakness or very unsatisfied; 10 = very satisfied. Unless stated, home outcomes refer to the first 24 postoperative hours.

In the light of recent advancements, USG imaging is being successfully used in foot and ankle surgeries. Ultrasound guidance has various advantages over anatomic landmark guidance procedures for anesthetists. Even with lower quantities of local anesthetic, the increased efficacy with this technique is due to factors like easy identification of peripheral nerves, viewing needle motions, and ability to observe the distribution of local anesthetic. In a recent analyzed prospective RCT study, clinical data demonstrated that when the USG technique for regional ankle block was compared to that of the ALG technique, the authors reported significant and improved results using the USG technique. These included improved success rates of anesthesia, decreased need for local anesthetic enhancement, block failures or unplanned need for general anesthesia and lastly, reduced even decreased need for postoperative analgesics[12]. Further literature also supports that the use of USG guided regional ankle block improved the onset of deep peroneal nerve block, although it did not largely enhance the desired quality of the block in comparison to the traditional anatomic landmark technique[22,23].

The role and effectiveness of ankle tourniquets have also been studied in the literature. Ankle tourniquets, in general, are known to be well tolerated. Using them efficiently slows down the absorption of an administered local anesthetic drug, hereby helping in providing a complete dose of chosen anesthetic with reduced systemic toxicity. However, in the literature, there are no standard protocols mentioned regarding the administration of ankle block depending on when the tourniquet is to be inflated.

In a prospective, randomized study by Gwosdz et al[20] conducted over a 6-month period on 41 patients, the authors examined the effects on perceived pain after administration of an ankle block alone or ankle block with local incision anesthetic in relation to the timing of ankle tourniquet inflation. They reported a statistically significant lesser mean VAS score only at 24 hours in patients who received an ankle block after tourniquet inflation with local anesthetic at closure in comparison to those who received an ankle block before tourniquet inflation. Furthermore, no difference in narcotic consumption was observed between groups at 24 and 48 hours. Hence as an advantage, when ankle blocks are used after tourniquet inflation, they might show less systemic absorption by keeping the anesthetic local". But in conclusion, they were of the opinion that timing of ankle block in relation to tourniquet inflation did not have an effect on pain control in forefoot, midfoot, and hindfoot reconstruction. Similarly, Singh et al[13], also reported that an ankle block, when used after tourniquet inflation, appears to be more efficacious in comparison to the one which is applied before tourniquet inflation. In yet another analyzed RCT by Kir et al[19], they also suggested that ankle block after tourniquet inflation was a safe technique and is known to have effective pain control. Although, its prolonged use may increase the chances of tourniquet-related transient palsy, which may persist as a transient loss or a permanent nerve injury. They reported one case each of transient nerve palsy in their study groups which resolved later without any additional treatment. They proposed that this could be due to the tourniquet use rather than the block itself.

In the present analysis of the 11 studies, 0.25%-0.5% bupivacaine was the most common local anesthetics used. Literature review shows that bupivacaine (0.25 percent and 0.5 percent) and lidocaine (1 percent and 2 percent) are the most often used local anesthetics in regional blocks for foot and ankle surgery. Bupivacaine has a longer duration of action than lidocaine, whereas lidocaine has a faster onset. Hence, the 1:1 ratio of bupivacaine and lidocaine serves well for most surgeons. In one of the reviewed articles, Chin et al[12] used a 50:50 mixture of plain 2% lidocaine and 0.5% bupivacaine for anesthesia.

In addition, corticosteroids like dexamethasone, when added to bupivacaine, increase the duration of analgesia. This can be attributed due to the upregulation of K+ channels in excitable cells and local action on nociceptor C-fiber mediated by the glucocorticoid receptor[24]. or else it can be an anti-inflammatory action of dexamethasone and blocking transmission on nociceptive fiber[25].

In the present analysis, in one of reviewed RCT by Fredrickson et al[14], they used a mixture of dexamethasone (8 mg) in addition to 0.5 % bupivacaine. They concluded when compared to systemic administration; perineural dexamethasone shows the least effectiveness on increasing the analgesic duration of bupivacaine in both sciatic and ankle blocks. Dexamethasone lengthened the time it took for the effects to wear off and even for normal sensation and mobility to recover.

Ropivacaine is a newer anesthetic agent with better central nervous and cardiovascular safety qualities. In another reviewed research article by Dawson et al[17], a mixture of Ropivacaine (0.75%)

in addition with dexamethasone 8 mg and 2 ml intravenous saline 0.9% has been used. They were of the opinion that dexamethasone lengthens the duration of ropivacaine ankle blocks when used either perineurally or intravenously[25].

Rudkin et al[10], from their study using bilateral ankle blocks, demonstrated the effectiveness of this block in 89 percent of their patients. Commenting on the anesthetic used, the average duration of action for Ropivacaine and clonidine, Ropivacaine, and ropivacaine and lignocaine combination was 17 hours, 14 hours, and 8 hours, respectively in their study with no adverse effects. Consequently, with the use of suitable doses of anesthetic drugs, patients continue to be at ease.

General anesthesia (GA) is also widely used in many places and is the chosen approach for foot surgeries. In these instances, an ankle block is frequently used as a supplement to general anesthesia to provide postoperative analgesia. Kir et al[19], in their randomized controlled trial, studied the effects of using GA alone and along with ankle block. They suggested that the use of GA along with ankle block proved to be better and might help to improve the postoperative condition and manage pain control in patients undergoing important surgeries like hallux valgus surgery. The postoperative pain VAS score after 24 hours a day was appreciably lower in patients of general anesthesia and ankle block group in comparison to ones in only general anesthesia group (2.96 ± 0.71 *vs.* 1.3 ± 0.65, $p < 0.01$). Furthermore, FANT was also found to be noticeably increased in these patients in comparison to the ones receiving only general anesthesia. Hence, an Ankle nerve block along with general anesthesia appears to decrease chronic as well as acute post-surgical pain with enhanced mobility during early and 1-year postoperative periods. Urfalioglu et al[16], in their study, compared both spinal anesthesia and ankle block. They found that ankle nerve block significantly increased the time to first analgesic requirement and provided a longer impact.

The failures, adverse effects, and other related complications of the registered studies in this analysis are listed in Table III. After reviewing all the prospective RCTs and retrospective studies included, we observed that all had demonstrated low failure rates and complications with regional anesthesia. Success rates, as reported by Rudkin et al[10], Samuel et al[11], Chin et al[12], and Schipper et al[18] were 86%, 96%, 84%, and 66%, 95.8%, respectively. Requirement of unplanned GA in failure cases as reported by Chin et al[12] included 7% cases with the use of USG guided while 17% cases in ALG technique. They further reported that the requirement of local anesthetic supplementation was greater in USG (5%) in comparison to ALG (10%); supplemental fentanyl was provided in 9% cases of USG while it was in 18% of cases with the ALG method. The use of opioid analgesics was also higher for the ALG method of regional ankle block. They mentioned that USG tibial and deep peroneal nerve blockade improved the success rate of ankle block in comparison to the conventional ALG technique[12].

In another reviewed research by Samuel et al[11], 38% cases in the combined popliteal and ankle block group required either codeine or morphine in addition to regular paracetamol, and the mean dose of codeine phosphate was 18 mg, and for morphine sulfate was 2.1 mg with a mean time of administration of additional analgesia after the surgery was 6.1 hours. Whereas in comparison, 59% of cases required additional anesthesia postoperatively in the group with ankle block alone. The mean dose of codeine phosphate was 78 mg, and morphine sulfate was 2.7 mg, with a mean time to the administration of additional analgesia of 9.1 hours.

Nerve injury after regional anesthesia is of particular concern to foot and ankle surgeons. Relating to this problem, one of our researchers, Fredrickson et al[14], reported that 78% of patients reported either numbness/ tingling or sharp pain and weakness postoperatively. Though, the authors mentioned that all cases were of transient paresthesia and were unrelated to the blocking technique used. The reason behind this was explained as a possibility due to dexamethasone-related local anesthetic neurotoxicity at clinical doses.

Regardless of the fact that we provide a valuable quantitative and qualitative synthesis of efficacy and outcomes from the literature on the administration of regional ankle blocks in ankle and foot surgeries, our study still presents many limitations. Obtained data in our analysis is relatively small, with a relatively limited number of patients. Moreover, the various techniques and combinations utilized by different authors in our analysis in order to achieve analgesia are diverse and even varied in relation to the local anesthetics used. This could have an effect on both immediate and long-term outcomes of the study. Higher-quality, multicentric, prospective studies focusing on patients receiving ankle block alone are still required. Furthermore, more detailed studies comparing the regional analgesia along with general anesthesia and studies focusing on various essential perioperative and postoperative hemodynamic parameters are still required, especially in medically compromised patients.

Conclusions

In foot and ankle surgeries, regional anesthetic has become a more appealing alternative, as it is safe and proves to be a highly effective method in the management of postoperative pain. With advantages like technical ease, excellent success rates with minimal side effects, high levels of patient satisfaction, and decreased hospital expenses, it has now gained popularity as an effective means of regional anesthesia for the majority of foot and ankle surgeries in outpatient settings.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Funding

The Authors would like to thank the Deanship of Scientific Research at Majmaah University for supporting and funding this study with project no. R-2021-279.

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