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REVIEW ARTICLE/BRIEF REVIEW

Perioperative pain management and chronic postsurgical pain after elective foot and ankle surgery: a scoping review

Prise en charge de la douleur périopératoire et douleur chronique post-chirurgicale après une chirurgie non urgente du pied et de la cheville : une revue exploratoire

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Abstract

Purpose *Chronic postsurgical pain (CPSP) can occur after elective mid/hindfoot and ankle surgery. Effective treatment approaches to prevent the development of CPSP in this population have not been extensively investigated. The impact of multimodal strategies to prevent CPSP following elective mid/hindfoot surgery is unknown because of both the heterogeneity of acute pain management and the lack of a recognized definition particular to this surgery. This review aimed to identify and evaluate current pain management strategies after elective mid/hindfoot and ankle surgery.*

Sources *Manual and electronic searches (MEDLINE, Embase, and Cochrane Library) were conducted of literature published between 1990 and July 2017. Comparative studies of adults undergoing elective mid/hindfoot and ankle surgery were included. Two reviewers independently reviewed studies and assessed their methodological quality.*

Principal findings *We found seven randomized-controlled trials meeting our inclusion criteria. Interventions focused on regional anesthesia techniques such as continuous popliteal sciatic and femoral nerve blockade. Participants were typically followed up to 48 hr postoperatively. Only one study assessed pain six months following elective mid/hindfoot and ankle surgery.*

Conclusion *There is an overwhelming lack of evidence regarding CPSP and its management for patients undergoing elective mid/hindfoot and ankle surgery. The lack of a recognized and standard definition of CPSP after this group of surgeries precludes accurate and consistent evaluation.*

Résumé

Objectif *La douleur chronique post-chirurgicale (DCPC) peut survenir après une chirurgie non urgente de la section moyenne ou postérieure du pied, ou de la cheville. Les approches thérapeutiques efficaces pour prévenir l'apparition de DCPC dans cette population n'ont pas été examinées en profondeur. L'impact des stratégies multimodales pour prévenir la DCPC après une chirurgie non urgente de la section moyenne ou postérieure du pied*

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est inconnu, tant en raison de l'hétérogénéité de la prise en charge de la douleur aiguë que du manque de définition reconnue spécifique à ce type de chirurgie. Ce compte-rendu a pour objectif d'identifier et d'évaluer les stratégies de prise en charge de la douleur actuellement utilisées après une chirurgie de la section moyenne ou postérieure du pied, ou de la cheville.

Sources *Des recherches manuelles et électroniques (MEDLINE, Embase, et Librairie Cochrane) ont été menées dans la littérature publiée entre 1990 et juillet 2017. Les études comparatives portant sur des adultes subissant une chirurgie non urgente de la section moyenne ou postérieure du pied ou de la cheville ont été incluses. Deux chercheurs ont indépendamment passé en revue les études et évalué leur qualité méthodologique.*

Constatations principales *Nous avons trouvé sept études randomisées contrôlées respectant nos critères d'inclusion. Les interventions se concentraient sur des techniques d'anesthésie régionale tels que les blocs continus des nerfs sciatiques poplités et fémoraux. Les participants bénéficiaient en général d'un suivi jusqu'à 48 h après l'opération. Une seule étude a évalué la douleur six mois après une chirurgie non urgente de la section moyenne ou postérieure du pied ou de la cheville.*

Conclusion *L'absence de données probantes est colossale en ce qui touche à la DCPC et à sa prise en charge pour les patients subissant une chirurgie non urgente de la partie moyenne ou postérieure et de la cheville. L'absence de définition normalisée et reconnue de la DCPC après ce type de chirurgie en exclut toute évaluation précise et cohérente.*

Chronic postsurgical pain (CPSP) occurs in several health-related areas, including elective mid/hindfoot and ankle surgery (e.g., arthrodesis and arthroplasty). While there are multiple and varied definitions for CPSP,[1-4] there is no accepted standard definition for CPSP in the context of this specific group of surgeries. The International Association for the Study of Pain (IASP) defines CPSP as pain developing after a surgical procedure, of at least two months duration, when other causes for the pain have been excluded.[4,5] The World Health Organization's International Classification of Diseases Eleventh Edition (ICD-11) defines CPSP as pain developing after a surgical procedure and persisting beyond the healing process (i.e., at least three months after surgery).[6]

Although efforts are currently being made towards standardizing the definition used by both organizations,[7] a definition for CPSP that is recognized by all disciplines involved with elective foot and ankle surgery does not yet exist. Consequently, CPSP incidence and prevalence can vary depending on the definition used.[8-10] For example, when defined as moderate-to-severe pain at one year after surgery,[11] the incidence of CPSP was 21% in patients undergoing elective mid/hindfoot and ankle surgery.[11] Another study reported that 23-60% of patients experienced residual pain after total ankle arthroplasty[12]; nevertheless, a definition of residual pain was not described and follow-up ranged from two to more than seven years postoperatively.[12] Given that CPSP affects patients' quality of life by limiting their physical function and negatively impacting their psychologic state,[13] standardizing and disseminating the definition of CPSP in the context of elective mid/hindfoot and ankle surgery is fundamental for the assessment of effective management strategies.

Despite its clinical importance, effective treatment approaches for CPSP prevention or management after elective mid/hindfoot and ankle surgery have not been extensively investigated.[14,15] In general, while opioids remain a cornerstone of postoperative pain management,[16,17] it is not clear if they are entirely effective for CPSP management as patients who continue to use opioids have higher pain levels, reduced independent function, and lower overall quality of life than those who have not been prescribed opioids.[18] It is therefore important to identify alternative effective treatments for CPSP following elective foot and ankle procedures.

Regional anesthesia techniques, as part of an acute perioperative multimodal pain management strategy, present a viable alternative to opioid use. Specifically, a recent review concluded that multimodal approaches for pain management (including regional anesthesia) reduce opioid use perioperatively while maintaining adequate pain control.[19] Although evidence is limited, multimodal analgesia has been shown to reduce the development of CPSP after total knee arthroplasty, breast cancer surgery, and major digestive surgery.[20-23] Unfortunately, few studies addressing acute perioperative multimodal pain management strategies have focused on CPSP prevention or management following elective mid/hindfoot and ankle surgery.[24]

Given the heterogeneity of approaches to recognizing and treating CPSP after elective mid/hindfoot and ankle surgery, we undertook a systematic scoping review to determine the current state of the evidence regarding the impact of acute pain management on CPSP development following elective mid/hindfoot and ankle surgery.

Methods

Search strategy

This review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses

(PRISMA) guidelines. MEDLINE, Embase, and Cochrane Library electronic databases were searched to find comparative studies published from January 1 1990 to July 20 2017 using the key terms "foot surgery," "ankle joint surgery," "postoperative pain," and "multimodal pain management". The search strategy was developed by a health sciences librarian in conjunction with orthopedic surgeons and pain specialists (see the Appendix for the full search strategy). Reference lists of relevant systematic reviews were also searched.

Study selection

Studies were included if they met the following criteria: a) included adult human patients undergoing elective mid/hindfoot and ankle surgery; b) were comparative studies, such as randomized-controlled trials (RCTs) or cohort studies with experimental groups investigating pre-, peri-, or postoperative pain management using either control groups or risk adjustment; and c) assessed relevant pain outcomes such as pain duration and/or intensity and opioid consumption. Articles were excluded if they: a) included fewer than ten participants per study arm (small sample size); b) were conference abstracts; c) were not in English; or d) if data from elective mid/hindfoot and ankle surgeries were not reported separately from other conditions/surgeries.

After duplicate citations were excluded, two reviewers independently assessed the study titles and abstracts identified by the initial search using Covidence software (Veritas Health Innovation, Melbourne, Australia). Following title and abstract screening, selected studies were carried forward to full text screening in a similar manner. Any conflicts were discussed between the two independent reviewers to come to an agreement; if an agreement was not possible, a third reviewer was consulted for a final decision.

Quality assessment

The quality of studies included in the study was evaluated by two independent reviewers using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for RCTs.[25]

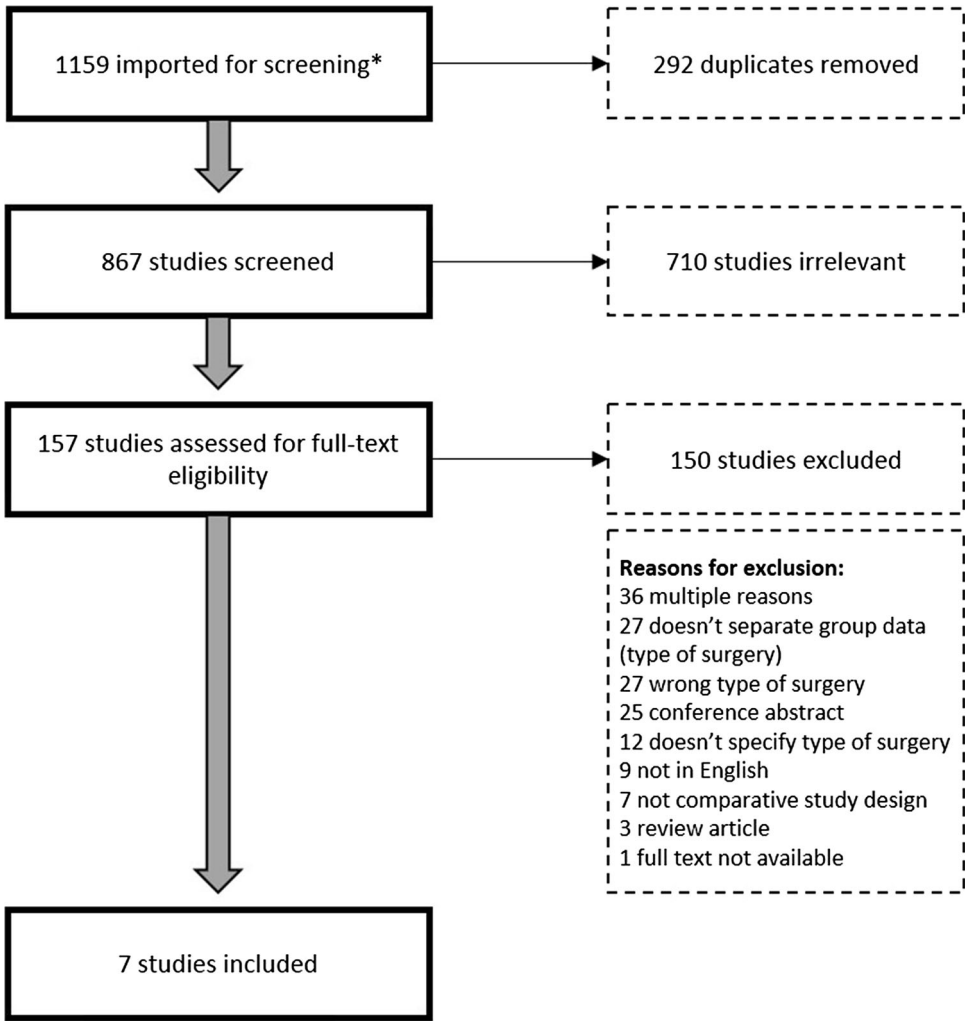

Figure PRISMA diagram. *Imported from electronic database and manual search

Table 1 JBI criteria for included studies

	JBI criteria	Author, year						
		Bendsten *et al*, 201126	Bjorn *et al*., 201727	Blumenthal *et al*., 201128	Elliot *et al*., 201029	Fisker *et al*., 201530	Rahangdale *et al*., 201431	Schoenmakers *et al*., 201532
1	Was true randomization used for assignment of participants to treatment groups?	Y	Y	Y	Y	Y	Y	Y
2	Was allocation to treatment groups concealed?	Y	Y	Unclear, Y	Y	Y	Y	Y
3	Were treatment groups similar at the baseline?	Y	Y	Y	Unclear	Y	Y	Y, N
4	Were participants blind to treatment assignment?	N	Y	N	Y	Y	Y	Y
5	Were those delivering treatment blind to treatment assignment?	N	Y	N	N	Y	Y	N
6	Were outcomes assessors blind to treatment assignment?	Y	Y	N	Y, Unclear	Y	Y	Y
7	Were treatment groups treated identically other than the intervention of interest?	Y	Y	Y	Y	Y	Y	Y
8	Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Y	Y	Y	Y	Y	Y	Y
9	Were participants analyzed in the groups to which they were randomized?	Y	Y	Y	Y	Y	Y	N
10	Were outcomes measured in the same way for treatment groups?	Y	Y	Y	Y	Y	Y	Y
11	Were outcomes measured in a reliable way?	Y	Y	Y	Y	Y	Y	Y
12	Was appropriate statistical analysis used?	Y	Y	Y	Y	Y	Y	Y
13	Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	Y	Y	Y	Y	Y	Y	Y
	Overall appraisal	Include	Include	Include	Include, seek further info	Include	Include	Include
	One response for agreement, two responses for disagreement (reviewer 1, reviewer 2)							
	Possible criteria ratings: Y (yes), N (no), Unclear, or N/A (not applicable)							
	Overall appraisal ratings: Include, Exclude, or Seek further information							

JBI = Joanna Briggs Institute

This checklist evaluates studies based on the following qualifications: true randomization, concealed allocation, similarity of baseline data, blinding, identical treatment other than the intervention given, completed follow-up, consistent group placement, consistent outcome measurement, reliable outcome measurement, appropriate statistical analysis, and appropriate trial design. Each study received a "Yes," "No," "Unclear," or "N/A (not applicable)" for each qualification.

Data extraction

Specific data from the included studies were extracted and inserted into a Microsoft Excel spreadsheet, which included country, study design, sample characteristics, surgical procedure, pain scores, analgesia type, and opioid consumption details, such as time to first postoperative opioid request and total postoperative opioid consumption.

Results

Study characteristics

The primary search retrieved 1,159 publications, of which 292 were duplicates. Of the 867 unique publications, title and abstract screening excluded 710, leaving 157 studies for full text screening. Following full text screening, 150

Table 2 Characteristics of included studies

Author, year	Study country	Sample characteristics sample size (*n*); age (yr); sex (%)		Consideration of preoperative chronic pain or opioid use?
		Control	Intervention	
Bendsten *et al.*, 2011[26]	Denmark	*n*=48 Age 56.2 (13.0) 58% male, 42% female	*n*=50 Age 56.5 (14.7) 64% male, 36% female	No
Bjorn *et al.*, 2017[27]	Denmark	*n*=20 Age 59.8 (13.5) 55% male, 45% female	*n*=19 Age 57.2 (12.6) 53% male, 47% female	Excluded patients with daily intake of opioids preoperatively
Blumenthal *et al.*, 2011[28]	Switzerland	*n*=25 Age 54 [22-78] 64% male, 36% female	*n*=25 Age 58 [41-80] 60% male, 40% female	Excluded patients with chronic pain and preoperative opioid therapy
Elliot *et al.*, 2010[29]	United Kingdom	*n*=27	*n*=27	No
Fisker *et al.*, 2015[30]	Denmark	*n*=24 Age 60.3 (10.2) 58% male, 42% female	*n*=20 Age 61.5 (13.0) 60% male, 40% female	Excluded patients with preoperative use of strong opioids (morphine and synthetic opioids)
Rahangdale *et al.*, 2014[31]	United States	*n*=27 Age 39 [23-60] 59% male, 41% female	Intervention 1: *n*=27 Age 42 [31-47] 52% male, 48% female Intervention 2: *n*=26 Age 47 [32-55] 50% male, 50% female	Excluded patients with chronic use of opioid (>3 months)
Schoenmakers *et al.*, 2015[32]	Netherlands	*n*=15 Age 61 (7) 53% male, 47% female	*n*=15 Age 56 (11) 60% male, 40% female	No

Ages presented as mean (SD) or median [interquartile range]

were excluded for the following reasons: wrong type of surgery, mid/hindfoot and ankle data not reported separately from excluded procedures, small sample size, full text not in English, or full text not available. In total, seven studies were included.[26-32] The PRISMA flow diagram is shown in the Figure.

All seven studies were RCTs, with publication dates ranging from 2010 to 2017.[26-32] The quality assessment of the seven studies according to the JBI Critical Appraisal Checklist for RCTs is shown in Table 1. All studies but one[31] were conducted in Europe.[26-30,32] Sample size ranged from 30 to 98 participants, most of whom underwent arthrodesis, calcaneal osteotomy or ankle replacement procedures. The average age of participants ranged from 39 to 62 yr old across trials.[26-32] Four of the seven included studies[27,28,30,31] excluded participants with preoperative chronic pain or opioid use (Table 2). In five out of the seven (71%) studies included in this review, participants were only followed for up to 48 hr postoperatively using postoperative pain scores and morphine consumption as outcomes.

All seven studies focused on regional anesthesia techniques, though interventions and techniques varied widely.[26-32] Interventions included comparison of ultrasound with nerve stimulation guidance for catheter insertion[26]; continuous versus single shot popliteal block[29]; addition of a continuous femoral block to continuous popliteal sciatic block[28]; addition of a continuous saphenous block to continuous popliteal sciatic block[27,30]; comparison of perineural versus systemic dexamethasone[31]; and use of perineural epinephrine as an adjunct (Table 3).[31,32]

Results of included studies

Postoperative opioid consumption

Table 4 summarizes the results of the included studies. All studies (n = 7)[26-32] involved techniques that used regional anesthesia as a core component of postoperative analgesia. Blumenthal *et al.* showed a significant reduction in mean (standard deviation [SD]) morphine consumption at both

Table 3 Procedures and interventions of included studies

Author, year	Control group	Intervention	Procedures	
			Control group	Intervention
Bendsten *et al.*, 2011[26]	Popliteal catheter insertion…		Calcaneal osteotomy (*n*=6, 12%)	Calcaneal osteotomy (*n*=7, 14%)
			Subtalar arthrodesis (*n*=8, 17%)	Subtalar arthrodesis (*n*=5, 10%)
			Total ankle replacement (*n*=25, 52%)	Total ankle replacement (*n*=24, 48%)
	…under nerve stimulation guidance	…under ultrasound guidance	Ankle arthrodesis (*n*=9, 19%)	Ankle arthrodesis (*n*=14, 28%)
Bjorn *et al.*, 2017[27]	Postoperative popliteal catheter infusion and		Total ankle replacement (*n*=11, 55%)	Total ankle replacement (*n*=10, 53%)
	preoperative saphenous nerve block of 0.5% bupivacaine (10 mL), 1:200,000 epinephrine, and…		Ankle arthrodesis (*n*=3, 15%)	Ankle arthrodesis (*n*=2, 11%)
			Subtalar arthrodesis (*n*=2, 10%)	Subtalar arthrodesis (*n*=5, 26%)
	…isotonic saline (1 mL)	…dexamethasone (1 mL)	Triple arthrodesis (*n*=4, 20%)	Triple arthrodesis (*n*=2, 11%)
Blumenthal *et al.*, 2011[28]	Popliteal nerve block and catheter infusion of 0.5% ropivacaine (30 mL) for 48 hr postoperatively and…		Ankle arthrodesis (*n*=11, 44%)	Ankle arthrodesis (*n*=9, 36%)
	…nothing	…femoral nerve block and catheter infusion of 0.5% ropivacaine (10 mL) for 48 hr postoperatively	Ankle prosthesis (*n*=14, 56%)	Ankle prosthesis (*n*=16, 64%)
Elliot *et al.*, 2010[29]	Popliteal nerve block of 0.5% bupivacaine (20mL) and, for 72 h postoperatively, popliteal catheter infusion of…		Ankle arthrodesis (*n*=7, 26%)	Ankle arthrodesis (*n*=6, 22%)
	…normal saline (4 $mL \cdot hr^{-1}$ with 1 mL patient-controlled bolus/hr)	…0.25% bupivacaine (4 $mL \cdot hr^{-1}$ with 1 mL patient-controlled bolus/hr)	Hind/midfoot arthrodesis (*n*=6, 22%)	Hind/midfoot arthrodesis (*n*=6, 22%)
			Ankle replacement (*n*=6, 22%)	Ankle replacement (*n*=6, 22%)
			Calcaneal osteotomy + tendon transfer (*n*=3, 11%)	Calcaneal osteotomy + tendon transfer (*n*=4, 15%)
			Tibio-talo-calcaneal arthrodesis (*n*=2, 18%)	Tibio-talo-calcaneal arthrodesis (*n*=3, 11%)
			Pan-talar arthrodesis (*n*=2, 8%)	Pan-talar arthrodesis (*n*=1, 4%)
			Tendo-Achilles reconstruction (*n*=1, 4%)	Tendo-Achilles reconstruction (*n*=1, 4%)
Fisker *et al.*, 2015[30]	Popliteal nerve block of 0.75% ropivacaine (20 mL) and catheter infusion of 0.2% ropivacaine (10 $mL \cdot hr^{-1}$); and saphenous nerve block of 0.375% ropivacaine (10 mL) and, for 48 hr postoperatively, saphenous catheter infusion of…		Total ankle replacement (*n*=14, 58%)	Total ankle replacement (*n*=7, 35%)
			Open ankle arthrodesis (*n*=3, 13%)	Open ankle arthrodesis (*n*=4, 20%)
			Subtalar arthrodesis (*n*=7, 29%)	Subtalar arthrodesis (*n*=9, 45%)
	…isotonic saline infusion (5 $mL \cdot hr^{-1}$)	…0.2% ropivacaine (5 $mL \cdot hr^{-1}$)		

Table 3 continued

Author, year	Control group	Intervention	Procedures	
			Control group	Intervention
Rahangdale *et al.*, 2014[31]	Saphenous nerve block and sciatic nerve block of 0.5% bupivacaine, 1:300,000 epinephrine, and…		Hindfoot (*n*=5, 19%) Ankle (*n*=22, 82%)	Intervention 1: Hindfoot (*n*=6, 22%) Ankle (*n*=21, 78%) Intervention 2: Hindfoot (*n*=5, 19%) Ankle (*n*=21, 81%)
	…perineural normal saline (2 mL) and intravenous normal saline (50 mL)	1) …perineural dexamethasone (8 mg/2 mL) and intravenous normal saline (50 mL) 2) …perineural normal saline (2 mL) and intravenous dexamethasone (8 mg/50 mL normal saline)		
Schoenmakers *et al.*, 2015[32]	Popliteal block with…		Ankle fusion (*n*=9, 60%) Subtalar fusion (*n*=6, 40%) Combination (*n*=0, 0%)	Ankle fusion (*n*=10, 67%) Subtalar fusion (*n*=4, 27%) Combination (*n*=1, 7%)

24 hr and 48 hr postoperative when using both a femoral and popliteal catheter [6 (5) mg at 24 hr and 9 (5) mg at 48 hr] compared with a popliteal catheter alone [25 (10) mg at 24 hr, $P < 0.05$; and 24 (11) mg at 48 hr, $P < 0.05$].[28] Bjorn *et al.* showed a significant reduction in morphine consumption at 24 hr postoperatively with the addition of perineural dexamethasone to continuous sciatic blockade; this intervention also increased the time until first opioid use after surgery (6.2 hr difference; $P < 0.05$).[27]

Despite the heterogeneity in the methodologies and interventions of the studies that looked at the use of dexamethasone as an adjunct, the use of perineural dexamethasone as an adjunct appeared to reduce postoperative opioid consumption[27] and improve analgesia compared with saline.[31] Bendsten *et al.* demonstrated that inserting popliteal catheters under ultrasound guidance compared with nerve stimulation guidance showed reduced morphine consumption at 48 hr postoperatively (median [range] 18 [0-159] mg compared with 34 [0-152] mg; $P < 0.05$).[26] In addition, studies comparing a single analgesic with multiple analgesics observed that the cumulative effect of multiple analgesics seems to be more effective for pain management than the use of single analgesics.[27,31]

Pain

None of the identified studies attempted to define CPSP after elective mid/hindfoot and ankle surgery. Although some studies reported no significant group differences in pain at 24 hr and 48 hr postoperatively,[27,32] others reported that analgesia was significantly improved with specific techniques.[28,29,31] Specifically, Blumenthal *et al.* observed that the addition of a continuous femoral block to a continuous popliteal block improved postoperative analgesia during movement at 24 hr (visual analogue scale [VAS], 0 *vs* 25; $P < 0.05$) and 48 hr (VAS, 0 *vs* 10; $P < 0.05$) postoperatively.[28] Similarly, Elliot *et al.* reported significantly lower pain scores in participants who received a continuous infusion of 0.25% bupivacaine via a popliteal catheter after a single bolus popliteal block at 24 hr (VAS, 1.7 *vs* 3.7; $P < 0.01$) and 48 hr (VAS, 1.3 *vs* 2.8; $P < 0.001$) compared with participants receiving saline.[29] Additionally, Rahangdale *et al.* found that pain was significantly reduced both with activity ($P < 0.05$) and at rest ($P < 0.01$) at 24 hr postoperatively and that analgesia duration was prolonged (median difference [range] 13 [7-19] hr) with adjunct perineural dexamethasone compared with normal saline.[31]

Importantly, only two studies examined the impact of early pain management beyond 48 hr rafter surgery; one study evaluated pain at two weeks postoperatively,[31] and another at six months postoperatively.[28] Rahangdale *et al.*

Table 4 Outcomes of included studies

Author, year	Pain score				Morphine consumption (mg)				Time to first opioid consumption	
	Control	Intervention	Control	Intervention	Control	Intervention	Control	Intervention	Control	Intervention
Bendsten *et al.*, 2011[26]	**NRS** Median [range]: 4 [0-10]	**NRS** Median [range]: 2.5 [0-8]	**NRS** Median [range]: 2 [0-7]	**NRS** Median [range]: 1.5 [0-7]			Mean [range]: 34 [0-152]	Mean [range]: 18 [0-159]*		
Bjorn *et al.*, 2017[27]	Data represented in graph form				Mean (SD): 11.9 (19.3)	Mean (SD): 1.9 (4.3)*	[24-48 hr] Mean (SD): 20.9 (19.3)	[24-48 hr] Mean (SD): 20.3 (20.7)	^Mean (SD) hr: 23.2 (10.3)	^Mean (SD) hr: 29.4 (8.4)*
Blumenthal *et al.*, 2011[28]	**^VAS** Mean (SD): 25 (22)	**^VAS** Mean (SD): 0 (17)*	**^VAS** Mean (SD): 10 (18)	**^VAS** Mean (SD): 0 (8)*	^Mean (SD): 25 (10)	^Mean (SD): 6 (5)*	^24-48 hr Mean (SD): 24 (11)	^24-48 hr Mean (SD): 9 (5)*		
Elliot *et al.*, 2010[29]	**^VAS** Median: 3.7	**^VAS** Median: 1.7**	**^VAS** Median: 2.8	**^VAS** Median: 1.3***	Median: 15	Median: 10	Median: 20	Median: 10***		
Fisker *et al.*, 2015[30]	**NRS** Median [IQR]: 4.0 [0.0-9.0]	**NRS** Median [IQR]: 3.0 [0.0-8.0]	**NRS** Median [IQR]: 1.0 [0.0-4.0]	**NRS** Median [IQR]: 2.0 [0.0-5.0]			^Mean (SD): 27.8 (20.1)	^Mean (SD): 24.7 (21.6)		
Rahangdale *et al.*, 2014[31]	**NRS** Median [IQR]: At rest: 4 [0-7] During activity: 4 [2-8]	**NRS** Median [IQR]: At rest**: (1) 0 [0-2] (2) 2.5 [0.5-5.5] During activity*: (1) 0 [0-4] (2) 3.5 [0-7]	**NRS** Median [IQR]: At rest: 2 [1-5] During activity: 4 [2-7]	**NRS** Median [IQR]: At rest: (1) 4 [1-5] (2) 3 [0.5-4.5] During activity: (1) 5 [2-7] (2) 5 [2.5-6.5]	Median [IQR] mEq morphine: 38 (23-45)	Median [IQR] mEq morphine: (1) 22 [15-45] (2) 34 [15-45]	Median [IQR] mEq morphine: 30 [15-38]	Median [IQR] mEq morphine: (1) 30 [15-45] (2) 23 [13-45]		
Schoenmakers *et al.*, 2015[32]	**NRS** Median [IQR] At rest: 1 [0-3] During activity: 1.5 [0-3] Max pain in 24 h: 4 [2-7]	**NRS** Median [IQR] At rest: 1 [1-3] During activity: 2 [1-3] Max pain in 24 h: 6 [3-8]							^Median [IQR] mins: 463 [300-1197]	^Median [IQR] mins: 830 [397-1128]

IQR = interquartile range; NRS = numeric rating scale; SD = standard deviation; VAS = visual analogue scale

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$

^Indicates primary outcome of the study

reported that there was no difference in postoperative pain levels and opioid consumption after two weeks when perineural or intravenous dexamethasone was used as an adjunct.[31] Blumenthal *et al.* found that pain with activity was significantly reduced at six months postoperatively when a femoral catheter was used in addition to a popliteal catheter alone for postoperative regional anesthesia.[28]

Discussion

Our scoping review examined postoperative pain management after elective mid/hindfoot and ankle surgery and found the current level of evidence for management of postoperative pain to be very limited and primarily focused on comparison of techniques or effectiveness of adjuncts for in-hospital regional anesthesia interventions. Although the levels of evidence for the included trials were generally high, most studies only included short-term (i.e., in-hospital) pain-related outcomes, including pain levels, morphine consumption, and time to first postoperative opioid use at 24 hr and 48 hr after surgery.[26-32] Encouragingly, multimodal analgesia approaches appeared to be effective in reducing or delaying opioid consumption while also providing effective pain management.[26-32]

Importantly, only two studies examined outcomes beyond 48 hr.[28,31] One study assessed pain at rest and with activity up to two weeks postoperatively.[31] While this is still prior to the development of CPSP as defined by either IASP or ICD-11,[3-6] the authors found that perineural or intravenous dexamethasone temporarily reduced pain at rest and with activity 24 hr postoperatively; nevertheless, this effect did not persist at either 48 hr or two weeks after surgery.[31] The only study that assessed pain beyond the acute phase found that the addition of a femoral catheter to a popliteal catheter for regional anesthesia was effective at both reducing morphine consumption at 24 hr and 48 hr after surgery and in decreasing pain with activity at six months.[28] Despite these promising results, only 50 patients were included in the study.

The findings of this scoping review highlight the need for further studies with longer follow-up of pain levels and opioid consumption and with a broader perspective of effective pain management strategies, including non-pharmacologic approaches, particularly in North American centres where opioid use is much higher than other global regions.[24,26] Furthermore, while short-term outcomes of pain-targeted interventions are important, the evaluation of long-term postoperative pain management outcomes and strategies is greatly needed. The current evidence does not allow us to evaluate whether effective perioperative pain management prevented CPSP development, effectively managed CPSP, or reduced postoperative opioid use following elective mid/hindfoot and ankle surgery.

Four of the seven (57%) studies included in this review[27,28,30,31] excluded patients who used opioids preoperatively (Table 2). While determining outcomes in opioid-naïve patients is important, preoperative opioid consumption has been associated with postoperative morbidity, mortality, and negative outcomes.[33,34] Given that orthopedic surgery patients have a higher prevalence of preoperative opioid use, they are at greater risk of developing opioid tolerance, leading to decreased analgesic effects over time and, consequently, dose escalation for pain control.[35,36] Therefore, future investigations of postoperative pain management should also include patients taking opioids preoperatively.

Patients undergoing elective mid/hindfoot and ankle surgery are commonly adults in a working age group (Table 2), which likely contributes to additional economic burden and loss of productivity as well as having a large impact on the patients' health-related quality of life and return to work.[37,38] Multimodal approaches that address patient and provider education, preoperative analgesia assessment, perioperative analgesia combinations, and postoperative non-pharmacological modalities have been recommended with emphasis on tailoring pain management to individuals' characteristics, prior history, and surgical procedure.[39,40] Although all included studies used a multimodal approach, no study included patient or provider education, non-pharmacologic analgesia modalities, or assessed other outcomes, such as functional activities, return to work, and health-related quality of life. Thus, little is known regarding the efficacy of such approaches in this population and further investigations are needed.

Strengths of this scoping review include a search strategy developed by a health science librarian in conjunction with appropriate clinicians, and a robust methodological approach that followed the PRISMA guidelines for a systematic review using Covidence software. The included studies were high quality and recent; thus, our short-term findings remain relevant to best practices for pain management immediately after elective mid/hindfoot and ankle surgery. These studies also further the understanding of CPSP management, as acute postoperative pain is associated with later development of CPSP.[41]

A limitation is the lack of evidence currently available regarding post-discharge and long-term outcomes after mid/hindfoot and ankle surgery. Longer follow-up would allow more thorough examination of postoperative pain, the incidence of CPSP, and total opioid/analgesic use in this patient population. This would allow analysis of factors

associated with the development of CPSP. Another limitation is the lack of standardization among studies as heterogeneous interventions were utilized in addition to different outcome scales and assessment periods. Standardized approaches and evaluations would facilitate synthesis of multiple studies to make more robust conclusions. Finally, no studies were identified comparing postoperative analgesia with or without regional anesthesia techniques.

Conclusion

Although this review found that specific regional anesthesia techniques and adjuncts may be effective for in-hospital analgesia following elective mid/hindfoot and ankle surgery, there is a paucity of evidence regarding longer term and associated outcomes as well as multimodal pain management. The lack of a standard definition of CPSP after elective mid/hindfoot and ankle surgery precludes accurate and consistent evaluation. Further epidemiological and comparative studies are required that focus on long-term follow-up after regional anesthesia and multimodal pain management interventions.

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Appendix: Search strategy

Foot and Ankle Postoperative Pain Search strategies July 20, 2017

Medline (via Ovid)

Foot and ankle postsurgical pain Medline July 2017

1. exp Foot/
2. exp Foot Injuries/
3. exp Foot Deformities/
4. exp Foot/su or exp Foot Injuries/su or exp Foot Deformities/su
5. exp Ankle Joint/ or exp Ankle/ or exp Ankle Injuries/ or exp Ankle Fractures/
6. exp Ankle Joint/su or exp Ankle/su or exp Ankle Injuries/su or exp Ankle Fractures/su
7. exp Arthroplasty, Replacement, Ankle/
8. 1 or 2 or 3 or 5
9. exp Orthopedic Procedures/
10. 4 or 6 or 7
11. (foot or ankle or heel or hindfoot or forefoot or talus or calcaneus or navicular).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
12. (surgery or surgical* or arthrodesis or fusion or arthroplast*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
13. 8 or 11
14. 9 or 12
15. 13 and 14
16. 10 or 15
17. exp Pain, Postoperative/
18. ((post-operative* or postoperative* or post operative* or post-surg* or postsurg* or post surg*) and (neuropath* or pain*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
19. 17 or 18
20. 16 and 19
21. exp Analgesics/
22. exp Analgesia/
23. (analges* or (pain adj control*) or (pain adj manag*) or narcotic* or opioid* or bloc*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
24. 21 or 22 or 23
25. 20 and 24
26. (multimodal or adjuvant or combin* or supplement* or compliment*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
27. 25 and 26
28. 20 and 26
29. 27 or 28

30. (protracted or prolong* or persist* or longterm or long-term or chronic* or duration or residual or unresolved).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
31. exp Postoperative Complications/
32. exp Pain/
33. exp Chronic Pain/
34. exp Pain Management/
35. exp Postoperative Period/
36. 31 or 35
37. 32 or 33 or 34
38. 36 and 37
39. 19 or 38
40. 16 and 39
41. 30 and 40
42. 26 and 41
43. limit 41 to (clinical trial or comparative study or controlled clinical trial or meta analysis or observational study or practice guideline or randomized controlled trial or systematic reviews)
44. 42 and 43

EMBASE

Foot and ankle postsurgical pain EMBASE July 2017

1. exp Foot/
2. exp Foot Injuries/
3. exp Foot Deformities/
4. exp Foot/su or exp Foot Injuries/su or exp Foot Deformities/su
5. exp Ankle Joint/ or exp Ankle/ or exp Ankle Injuries/ or exp Ankle Fractures/
6. exp Ankle Joint/su or exp Ankle/su or exp Ankle Injuries/su or exp Ankle Fractures/su
7. exp Arthroplasty, Replacement, Ankle/
8. 1 or 2 or 3 or 5
9. exp Orthopedic Procedures/
10. 4 or 6 or 7
11. (foot or ankle or heel or hindfoot or forefoot or talus or calcaneus or navicular).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]
12. (surgery or surgical* or arthrodesis or fusion or arthroplast*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]
13. 8 or 11
14. 9 or 12
15. 13 and 14
16. 10 or 15
17. exp Pain, Postoperative/
18. ((post-operative* or postoperative* or post operative* or post-surg* or postsurg* or post surg*) and (neuropath* or pain*)).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]
19. 17 or 18
20. 16 and 19
21. exp Analgesics/
22. exp Analgesia/
23. (analges* or (pain adj control*) or (pain adj manag*) or narcotic* or opioid* or bloc*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]
24. 21 or 22 or 23
25. 20 and 24
26. (multimodal or adjuvant or combin* or supplement* or compliment*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]
27. 25 and 26
28. 20 and 26
29. 27 or 28
30. (protracted or prolong* or persist* or longterm or long-term or chronic* or duration or residual or unresolved).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]
31. exp Postoperative Complications/
32. exp Pain/
33. exp Chronic Pain/
34. exp Pain Management/
35. exp Postoperative Period/
36. 31 or 35
37. 32 or 33 or 34
38. 36 and 37
39. 19 or 38
40. 16 and 39
41. 30 and 40
42. 26 and 41
43. limit 41 to (clinical trial or randomized controlled trial or controlled clinical trial or multicenter study)
44. exp cohort analysis/
45. exp comparative study/
46. exp practice guideline/
47. 44 or 45 or 46
48. 41 and 47
49. limit 41 to "systematic review"
50. 43 or 48 or 49
51. exp malignant neoplasm/
52. exp foot ulcer/ or exp diabetic foot/
53. exp total knee arthroplasty/

54. 51 or 52 or 53
55. 50 not 54
56. 55 not cancer*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]
57. 56 not (tumor* or tumour*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]
58. 57 not shoulder*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word]

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