Review Article

Quadratus lumborum block vs. transversus abdominis plane block for caesarean delivery: a systematic review and network meta-analysis*

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Summary
Caesarean delivery is the most commonly performed inpatient surgical procedure globally. Pain after caesarean delivery is moderate to severe if not adequately treated, and is a primary anaesthetic concern for patients. Transversus abdominis plane and quadratus lumborum blocks are fascial plane blocks that have the potential to improve analgesia following caesarean delivery. Although proponents of the quadratus lumborum block suggest that this technique may provide better analgesia compared with transversus abdominis plane block, there are limited data directly comparing these two techniques. We, therefore, performed a systematic review and network meta-analysis to compare transversus abdominis plane and quadratus lumborum block approaches, seeking randomised controlled trials comparing both techniques to each other, or to control, with or without intrathecal morphine. In all, 31 trials with 2188 patients were included and our primary outcome, the cumulative intravenous morphine equivalent consumption at 24 h, was reported in 12 trials. In the absence of intrathecal morphine, transversus abdominis plane and quadratus lumborum blocks were equivalent, and both were superior to control (moderate-quality evidence). In the presence of intrathecal morphine, no differences were found between control, transversus abdominis plane and quadratus lumborum blocks (moderate-quality evidence). Similar results were found for resting and active pain scores at 4–6 h, 8–12 h, 24 h and 36 h, although quadratus lumborum block was associated with lower pain scores at 36 h when compared with transversus abdominis plane block (very low-quality evidence). However, transversus abdominis plane block was associated with a reduced incidence of postoperative nausea and vomiting (moderate-quality evidence) and sedation when compared with inactive control following intrathecal morphine administration (low-quality evidence). There are insufficient data to draw definitive conclusions, but transversus abdominis plane and quadratus lumborum block appear to be superior to control in the absence of intrathecal morphine, but provide limited additional benefit over inactive control when intrathecal morphine is also used.

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Accepted: 26 May 2020
Keywords: analgesia; block; caesarean delivery; obstetrics; quadratus lumborum; regional anaesthesia; transversus abdominis plane block

[Correction added on 4 January 2021, after first online publication: Tables S2 to S30 have been corrected this version]
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Introduction

Caesarean delivery is the most common inpatient surgical procedure performed worldwide; improving the perioperative care of parturients has significant global implications [1]. Acute postpartum pain is a leading anaesthetic concern for women [2]; is a key determinant of maternal satisfaction [3]; may lead to persistent postoperative pain [4, 5]; is a predictor of postpartum depression [6]; and can reduce early breastfeeding success [7]. Effective postoperative analgesia should, therefore, be prioritised to improve outcomes following caesarean delivery.

Multimodal analgesia, including long-acting intrathecal or epidural opioid, is standard for postoperative caesarean delivery analgesia. In the absence of long-acting neuraxial opioid, truncal blocks such as transversus abdominis plane (TAP) blocks and quadratus lumborum blocks (QLB), are increasingly being incorporated into obstetric anaesthetic practice to improve analgesic outcomes [8–13]. However, no visceral analgesia is provided with TAP blocks, and thus the QLB may offer improved analgesic efficacy due to possible injectate spread to the paravertebral space [14, 15]. Quadratus lumborum blocks have been studied in several obstetric randomised controlled trials, and advocates of this technique postulate that it is associated with superior analgesic outcomes when compared with either control or TAP blocks [16]. However, there are few direct comparisons between the two techniques and there have been no trials synthesising the available data and comparing the analgesic efficacy of QLB vs. TAP blocks following caesarean delivery.

We aimed to perform a systematic review of randomised controlled trials of TAP blocks and QLB for women undergoing caesarean delivery. Because few trials have compared the techniques directly, we planned to perform a network meta-analysis to pool and analyse the available data to compare the analgesic efficacy of TAP blocks vs. QLB. We hypothesised that the QLB would be associated with decreased 24-h cumulative morphine equivalent consumption, as well as other analgesic outcome metrics, compared with both TAP blocks and control, in the presence and absence of long-acting intrathecal opioid analgesia.

Methods

This systematic review and network meta-analysis was registered with PROSPERO and adhered to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) recommendations [17]. A literature search was performed by a medical librarian (LB). An exhaustive systematic review was undertaken of the following databases: MEDLINE through PubMed; Embase; Web of Science; Cochrane Central Register of Controlled Trials; Cumulative Index to Nursing and Allied Health (CINAHL); clinicaltrials.gov; and PROSPERO databases from inception until 23 October 2019. We used controlled vocabulary terms and free text terms in various permutations and language formats combined with Boolean operators for the primary elements of this review, which were: quadratus lumborum block; transversus abdominis plane block; and caesarean delivery. To identify trials that were not identified by our strategy, we supplemented it by hand-searching reference lists of included trials, published systematic reviews and meta-analyses. Full-text articles were required, but the search was not limited by language or risk of bias.

Trials recruiting patients receiving elective or emergency caesarean delivery under spinal (with or without intrathecal morphine or other long acting neuraxial opioid), epidural or general anaesthesia were included. We included all doses of neuraxial opioids administered. We sought randomised controlled trials comparing the analgesic efficacy of: QLB vs. control; QLB vs. TAP block; or TAP block vs. control. The approach to QLB (lateral; posterior; anterior) and TAP block (subcostal; lateral; ultrasound-guided) was not a factor in determining study eligibility. We also considered all trials using QLB or TAP blocks administered via single-injection or catheter, and considered all local anaesthetic doses. For the purposes of this study, inactive control was deemed to be either: sham block (mock block); placebo (block with saline); or control (no attempted block). We excluded trials using other neuraxial adjuncts such as clonidine and ketamine, and trials utilising blocks for rescue analgesia rather than prevention of postoperative pain. We excluded abstracts, reviews and editorials. Trials evaluating combination blocks such as ilioinguinal and TAP blocks were also excluded.

Shortlisted articles were entered into the Rayyan reviewing system online [18]. Title and abstract screening, and subsequent full-text screening, were conducted independently by two authors (KE and ND) and disagreements were resolved by discussion with a third author (PS). All included trials were then reviewed by all authors to ensure eligibility criteria were met. We assessed all included trials for the risk of bias using the Cochrane Collaboration’s risk of bias tool [19]. This included: random sequence generation; concealment of treatment allocation; blinding throughout the study period; attrition; selective outcome reporting; and any other risk of bias.
Data extraction was performed by four authors independently (KE, ND, SB and PO) on to standardised Microsoft Excel 2018 forms (Microsoft, Redmond, WA, USA). Extracted data included: trial characteristics; patient demographics; primary anaesthesia details (general vs. neuraxial); peri-operative analgesic regimen; interventional and control details; rest and active pain scores; cumulative morphine equivalent consumption; and opioid-related complications. Data presented in a graphical format only were extrapolated with plot digitisation software (Plot Digitizer, 2.1, Free Software Foundation, Boston, MA, USA). In cases of incomplete or unreported data, corresponding authors were contacted up to three times.

The primary outcome was cumulative 24 h morphine equivalent consumption. Secondary opioid-related outcomes were morphine-equivalent consumption at: 0–2; 4–6; 8–12; 18; 24; 36; 48; and 72 h. All opioid consumption was converted to intravenous (i.v.) morphine equivalents (mg) using standardised conversion tables from the British National Formulary [20]. The time to first analgesic administration was also sought. Pain scores at rest, or with coughing or movement, were assessed using the visual analogue scale (VAS) 0–100 linear point scale at: 0–2; 4–6; 8–12; 18; 24; 36; 48; and 72 h. Where a 0–10 numerical rating score (NRS) was used, this was converted to a 0–100 score by multiplying the number by 10. The incidence of opioid-related side-effects was collected to include: sedation; respiratory depression; postoperative nausea and vomiting; and pruritus at 24 and 48 h. We also assessed the time to ambulation; patient satisfaction; and patient-reported outcome measures in the form of the obstetric quality of recovery score, Obs-QoR-11 [21]. Patient satisfaction scores reported using discrete scores on scales other than a 0–100 point scale were converted to continuous values with previously described linear transformation methodology [22]. Where mean and standard deviation (SD) were not presented for any outcomes examined, the median, interquartile range (IQR) and range were used to estimate them using standardised conversion equations [23].

Data were entered into Stata® (Version 16.0, StataCorp LLC, Texas, USA) by one author (ND) and checked by another author (SH). We aimed to conduct a network meta-analysis with a common heterogeneity parameter and multivariate meta-analysis methods for an outcome of interest if at least three or more interventions through direct comparisons formed a network of interventions [24, 25]. In network meta-analysis, interventions can be compared directly and indirectly, the latter via mathematical manipulation of the estimates of the direct intervention effect as a common comparator. Importantly, indirect comparisons facilitate the estimation of the relative effects of interventions that have not been previously compared directly within a randomised controlled trial. If the resulting network model was disconnected, that is, there was at least one pair of interventions not compared directly or indirectly, then the network meta-analysis was performed separately for interventions with and without intrathecal morphine. The quality of evidence for each outcome subjected to network meta-analysis was rated for: risk of bias; inconsistency; indirectness; imprecision; publication bias; and an overall grading of the quality of evidence was produced, with reference to the grading of recommendations assessment, development and evaluation (GRADE) system [26].

Heterogeneity was evaluated by judgment of the confidence intervals and whether it excluded the null effect and the clinically important effect in the opposite direction to the point estimate. Inconsistency includes: heterogeneity (consequent to clinical or methodological diversity) and incoherence (disagreement between direct and indirect estimates for the same comparison). Heterogeneity was evaluated by judgment of the agreement between the confidence and the prediction intervals in relation to the null effect and the clinically important effect in the opposite direction from the point estimate. The prediction interval is expected to include the true intervention effect in future trials. Incoherence was assessed locally with the separating indirect from direct evidence (sidesplit function) approach and globally with the design-by-treatment interaction test. In this respect, a p value < 0.05 signifies major concerns. To evaluate the risk of publication bias, a comparison-adjusted funnel plot was drawn and visually examined. Our results were verified by performing of Egger’s linear regression test.

If the data for an outcome of interest could not be analysed by network meta-analysis, and provided the outcome was reported by two or more randomised controlled trials, then we conducted pairwise meta-analysis using Review Manager (Version 5.3, The Nordic Cochrane Centre, Copenhagen, Denmark). Heterogeneity (I²) was calculated for each outcome with predetermined thresholds for low (25–49%), moderate (50–74%) and high (≥ 75%) levels [27]. If low heterogeneity was found, it was assumed that the true effect of the intervention was the same in every included trial, and a fixed-effect model was chosen to represent the best estimate of the intervention effect. In the event that moderate or high heterogeneity was present, it was assumed...
that the effect of the intervention was not the same in every included trial but followed the same distribution, and the DerSimonian and Laird random effects model was chosen to represent the average intervention effect. For continuous outcomes, data were subjected to the inverse-variance method, where the weight assigned to each trial is selected to be the inverse of the variance of the effect estimate, resulting in the calculation of a weighted mean difference (95%CI). For dichotomous outcomes, we calculated the risk ratio (95%CI) using random-effects modelling. All tests were two-tailed and performed at the 5% statistical significance level.

Results
Out of the initial 59 unique article citations identified by the search strategy, 31 randomised controlled trials comprising a total of 2188 patients fulfilled the inclusion criteria (Fig. 1) [16, 28, 37–46, 29, 47–56, 30, 57, 31–36]. Twenty-two, seven and two trials, with or without intrathecal morphine, compared TAP block with control, QLB with control and TAP with QLB, respectively. The primary mode of anaesthesia was central neuraxial blockade in 29 trials and general anaesthesia in two, while 15 trials included patients receiving intrathecal morphine. Characteristics of the trials are detailed in Table S1 with their risk of bias assessment presented in Figure 2 and its summary in Figure S1, online Supporting Information. In the seven instances where we needed to clarify details of trial methodology or requested missing data, one author responded with the required information [57].

Our primary outcome, the cumulative i.v. morphine-equivalent consumption at 24 h, was reported in 12 trials [10, 16, 53, 56, 28, 29, 44, 47, 49–52]. Of the data from all trials analysed, the resulting network was disconnected and so two separate network models were constructed, one with and one without trials including intrathecal morphine (Fig. 3). In the absence of intrathecal morphine, QLB and TAP block were equivalent and both were superior to control (Table 1). In the presence of intrathecal morphine, no evidence of differences were found between control, QLB and TAP block. Both direct views of the comparison-adjusted funnel plot and Egger’s test suggested that publication bias was not present ($p = 0.93$; Fig. 4). The quality of evidence was rated as moderate and network ranking of the interventions was not performed in view of the serious imprecision.

For secondary outcomes, the results of the meta-analyses are presented in Table 2 (see also Supporting Information, Tables S2–30). In the absence of neuraxial morphine, QLB and/or TAP block were demonstrated to be superior to control in reducing the pain score at rest at 4–6 h, 8–12 h, 18 h, 24 h and 36 h; the pain score on movement at 4–6 h, 8–12 h, 24 h, 36 h and 48 h; and the cumulative i.v. morphine-equivalent consumption at 4–6 h, 8–12 h, 36 h and 48 h. Quadratus lumborum block was more effective than TAP block in reducing pain scores at rest and on movement at 36 h (very low-quality evidence), but no differences were found between these two techniques for any other analgesia-related outcomes. In the presence of

![Figure 1](study_flow_diagram.png)  
**Figure 1** Study flow diagram summarising the retrieved, included and the excluded randomised controlled trials.
neuraxial morphine, then supplementation with QLB was not superior to control for any of the outcomes, and TAP block was only superior to control in decreasing the pain score at rest and on movement at 0–2 h (moderate-quality

Figure 2  Risk of bias assessment of included trials using the Cochrane Collaboration’s tool. ?, unclear risk; - , high risk; +, low risk.

Figure 3  Network plot: (a) without intrathecal morphine; and (b) with intrathecal morphine for cumulative intravenous morphine-equivalent consumption at 24 h. Each intervention is depicted by a circle that is proportional in size to the number of patients who were randomised to that intervention. Connecting lines between the circles indicate the direct comparisons of interventions, their width proportional to the number of trials evaluating the comparison and their colour representing the risk of bias related to the blinding of participants and personnel. Green, low risk; yellow, unclear risk; red, high risk. ITM, intrathecal morphine; QLB, quadratus lumborum block; TAP, transversus abdominis plane.

neuraxial morphine, then supplementation with QLB was not superior to control for any of the outcomes, and TAP block was only superior to control in decreasing the pain score at rest and on movement at 0–2 h (moderate-quality
In terms of side-effects at 24 h, TAP block was associated with a reduced incidence of postoperative nausea and vomiting (moderate-quality evidence) as well as sedation (low-quality evidence), relative to control with intrathecal morphine. Only one study reported on the obstetric quality of recovery score, ObsQoR-11, for which there was no difference between QLB and control [51].

**Discussion**

This is the first systematic review and network meta-analysis comparing the analgesic efficacy of QLB and TAP blocks after caesarean delivery. Contrary to our hypothesis, QLB was not associated with a reduction in 24 h i.v. morphine equivalent consumption when compared with TAP block. In the absence of intrathecal morphine administration, QLB and TAP block were equivalent and superior in their analgesic efficacy relative to inactive control for up to 48 h, reducing 24 h i.v. morphine equivalent consumption by approximately 20 mg. Moreover, in the presence of intrathecal morphine, QLB and TAP blocks did not provide any additional analgesic advantage over inactive control. The modest quantity and quality of available data should be interpreted with caution.

Consistent with our results, previous systematic reviews have demonstrated the efficacy of TAP block when compared with inactive control for caesarean delivery, and

**Table 1** Network league table for all the interventions (a) without; and (b) with intrathecal morphine regarding cumulative intravenous morphine-equivalent consumption (mg) at 24 h. Estimates are presented as mean difference (95%CI; 95% predictive interval) without intrathecal morphine and mean difference (95%CI) with intrathecal morphine. Data were not sufficient to calculate the 95% predictive interval for trials that included intrathecal morphine. If the mean difference is below 0, the column intervention is favoured and should it be above 0, then the row intervention is favoured. Interventions were significantly different if the 95%CI did not include 0 and are in bold type.

(a)

|            | Control | QLB     | TAP block |
|------------|---------|---------|-----------|
| Control    | 17.00 (4.71 to 29.29; –13.14 to 47.14) | 21.89 (12.17 to 31.61; –6.92 to 50.70) | 4.89 (–9.02 to 18.80; –26.21 to 35.99) |

(b)

|            | Control and ITM | QLB and ITM | TAP block and ITM |
|------------|-----------------|-------------|-------------------|
| Control and ITM | 6.50 (–3.28 to 16.28) | –2.10 (–10.21 to 6.01) | –8.60 (–21.30 to 4.10) |

ITM, intrathecal morphine; QLB, quadratus lumborum block; TAP, transversus abdominis plane.
| Outcome | Number of trials | Total number of participants | Number of direct comparisons | Number of indirect comparisons | Conclusion | Quality of evidence | Comments |
|---------|------------------|-------------------------------|-----------------------------|-------------------------------|------------|---------------------|----------|
| Cumulative i.v. morphine-equivalent consumption | | | | | | | |
| 8–12 h  | Network (No ITM) | 8 | 429 | 3 | 0 | QLB and TAP superior to control | Low quality (⊕⊕) | Rated down for serious inconsistency and serious imprecision |
| 24 h    | Network (No ITM) | 10 | 517 | 3 | 0 | QLB and TAP superior to control | Moderate quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |
|        | Network (ITM)   | 2 | 160 | 2 | 1 | No differences between interventions | Moderate quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |
| 48 h    | Network         | 8 | 522 | 7 | 8 | QLB and TAP superior to control | Low quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |
| Pain score at rest | | | | | | | |
| 8–12 h  | Network         | 17 | 1096 | 7 | 8 | QLB and TAP superior to control | Moderate quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |
| 24 h    | Network         | 21 | 1415 | 12 | 3 | TAP superior to control | Low quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |
| 48 h    | Network         | 13 | 808 | 9 | 6 | No differences between interventions | Low quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |
| Pain score on movement | | | | | | | |
| 8–12 h  | Network         | 15 | 916 | 7 | 8 | Control inferior to all other interventions | Moderate quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |
| 24 h    | Network         | 20 | 1307 | 12 | 3 | Control inferior to control & ITM and TAP | Low quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |
| 48 h    | Network         | 13 | 807 | 9 | 6 | QLB superior to control | Moderate quality (⊕⊕⊕) | Rated down for serious inconsistency and serious imprecision |

ITM, intrathecal morphine; QLB, quadratus lumborum block; TAP, transversus abdominis plane.
have indicated its superiority in the absence of intrathecal morphine administration, although this effect diminishes when intrathecal morphine is used [11, 12, 58]. Additionally, two trials included in this network meta-analysis reported superior analgesic efficacy when TAP blocks were compared with QLB in patients having caesarean delivery [16, 57]. Contrary to these single-centre trials, our current data synthesis is the first to show similar analgesic outcomes when QLB and TAP blocks are used in the same settings. The mechanism of action of TAP blocks are well-described, yet there remain mechanistic uncertainties regarding QLB [15, 59, 60]. The purported visceral analgesia achieved by QLB is thought to be sympathetically mediated [15], yet limited evidence supports this theory. The clinical data we have analysed suggest that there could be similar mechanisms of action of both blocks. In particular, blockade of the ilio-inguinal, iliohypogastric and lateral cutaneous branches of the thoraco-abdominal nerves (T10–12) nerves might be achieved at a distal portion of the course of the nerves with a TAP block, but more proximally at the level of the lumbar plexus and the paravertebral space with a QLB [61]. Crucially, the similarities in clinical effect somewhat undermine theories of visceral analgesia with QLB for caesarean delivery, although this effect could still be apparent in other surgical settings [62]. It should be noted that most of the trials that evaluated QLB used lateral and posterior approaches, which may theoretically result in less paravertebral spread, and therefore inferior profiles of analgesia and ambulation, compared with the anterior approach [15]. Of note, QLB was inferior to TAP block and control in terms of time to ambulation (Table S28), whereas TAP blocks were superior to QLB and control for this outcome. These findings further support a possible lumbar plexus mechanism of action for QLB, and thus the motor-sparing effect of TAP blockade.

The safety and ease of performing TAP block vs. QLB warrants some consideration. While both techniques require ultrasound guidance, TAP block is seen as easier to perform and requires a lower level of expertise than QLB. Related to this is the potential for damage to nearby organs such as the kidney, which is in proximity to the QLB anterior approach, and blood vessels, although there are no data reported on this as yet. There have been reports of local anaesthetic systemic toxicity with the use of TAP block in caesarean delivery [63, 64], yet this has not been reported in patients receiving QLB. Local anaesthetic volume, concentration and dosing strategies, together with the efficacy of long-acting local anaesthetics and catheter techniques deployed using these two techniques, are areas that also warrant further research.

Central neuraxial blockade is seen as the standard of care for caesarean delivery [65], and despite the potentially increased time required to achieve surgical anaesthesia when urgent delivery is needed, it is not associated with worse neonatal outcomes [66]. Given the broad application of neuraxial blockade, the addition of intrathecal morphine is a simple, cost-effective and relatively safe analgesic intervention that has long been utilised. However, adverse effects, such as postoperative nausea and vomiting, sedation and pruritus occur in a dose-dependent manner [67]. We found that TAP was superior to both QLB and intrathecal morphine for the risk of nausea and vomiting at 48 h and TAP blocks were also superior to intrathecal morphine at 24 h. Additionally, the lower incidence of sedation associated with TAP blocks compared with intrathecal morphine at 24 h represents a further benefit of using this approach, despite the lack of superiority over QLB. Thus, the adverse effect profile of TAP blocks may have marginal benefits over QLB and intrathecal morphine [68].

This systematic review has several limitations. As with most systematic reviews, heterogeneity of the included trials must be considered. Anterior, lateral and posterior approaches to the QLB were included, and we pooled all of these different techniques as ‘quadratus lumborum blocks’. Varying clinical efficacy and local anaesthetic spread have been noted for the different approaches of QLB, and thus this could hamper interpretation of these results [69]. Moreover, we included data from patients that had caesarean delivery under either general anaesthesia or central neuraxial blockade. The effect of systemic analgesia administered during general anaesthesia may have contributed to the heterogeneity in patient outcomes. However, this was from a single study, and therefore the impact on our results are unlikely to be marked. Additionally, a range of local anaesthetic drugs, volumes and dosage were given, and there was variation in the reported application of postoperative multimodal analgesia. This inconsistency, as well as imprecision, of included trials meant that our assessment of study quality according to the GRADE criteria, were of low or moderate quality. There is limited evidence reporting patient-centred outcome measures, and the effect of analgesic interventions on the quality of recovery remains a critical avenue to explore. The number of trials included in the network meta-analysis is modest, and therefore interpretation of these results must be tempered until further research builds upon the existing data. Finally, we conducted this network meta-analysis using frequentist statistical approaches, and Bayesian techniques could have
been implemented. However, it is unlikely that the results would be sufficiently different, and both techniques have limitations[70].

In conclusion, the results of this systematic review and network meta-analysis of QLB compared with TAP block for analgesia following caesarean delivery suggest that both interventions provide comparable postoperative analgesia and opioid-sparing effects. Both techniques were superior to inactive control in the absence of intrathecal morphine, yet did not result in additional benefit relative to inactive control when intrathecal morphine was used. However, the modest data available, along with methodological limitations, mean that these data should be interpreted with caution until future studies corroborate these findings.

Acknowledgements
This study was registered with PROSPERO (registration ID: CRD42020165161). KE is an Editor of Anaesthesia and has received educational and research funding from Fisher and Paykel Healthcare Ltd., GE Healthcare and Ambu. No other competing interests are declared.

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Supporting Information
Additional supporting information may be found online via the journal website.

Figure S1. Summary of the risk of bias of all included trials.
Table S1. Characteristics of the included trials.
Tables S2–29. Network league table for all outcomes and interventions, with or without intrathecal morphine. Estimates are presented as mean differences (95%CI). Mean differences < 0 favour the column intervention and mean differences > 0 favour the row intervention. Interventions in bold are significantly different since the 95%CI does not include 0.
Table S30. Conclusion from the results of the meta-analysis and GRADE quality of evidence assessment for every outcome.