

Living Friendly Summaries Of The Body Of Evidence Using Epistemonikos (FRISBEE)

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Is intravenous ketamine effective for postoperative pain management in adults?

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Abstract

Ketamine is a N-Metil-D-Aspartate receptor antagonist that has been used as adjuvant in the acute postoperative pain management because of its analgesic properties. However, its role is not clearly determined. To answer this question, we searched in Epistemonikos database, which is maintained by screening multiple information sources. We identified 19 systematic reviews including 226 randomized trials overall. We extracted data and generated a summary of findings table using the GRADE approach. We concluded intravenous ketamine probably has little or no effect in reducing postoperative pain.

Problem

Postoperative pain management is an important aspect in anesthesiology practice. Opioids are commonly used because of its effectiveness but they have adverse effects, such as nausea, vomiting, sedation and respiratory depression. One alternative strategy is to use adjuvant analgesics that through different pain pathways would reduce the incidence of undesirable effects.

The N-Metil-D-Aspartate receptor is an ionotropic glutamate receptor that has been implicated in pain mechanisms modulation. Ketamine is a non-competitive antagonist of N-Metil-D-Aspartate receptor and it has been used in low doses as adjuvant in postoperative pain management. However, its clinical use is still controversial because of its potential psychomimetic adverse effects such as nausea, vomiting and hallucinations.

Methods

We used Epistemonikos database, which is maintained by screening multiple information sources, to identify systematic reviews and their included primary studies. With this information we generated a structured summary using a pre-established format, which includes key messages, a summary of the body of evidence (presented as an evidence matrix in Epistemonikos), a summary of findings table following the GRADE approach and a table of other considerations for decision-making.

Key messages

- Intravenous ketamine probably has little or no effect in reducing postoperative pain.
- Intravenous ketamine probably does not increase postoperative sedation, but it is not clear whether it increases the risk of nausea and vomiting because the certainty of the evidence is very low.

About the body of evidence for this question

<p>What is the evidence. See evidence matrix in Epistemonikos later</p>	<p>We found 19 systematic reviews [1-19] including 226 [20-245] randomized trials. One hundred eleven were trials including the use of intravenous ketamine in adult patients, corresponding to the question addressed by this summary [20-130].</p>
<p>What types of patients were included*</p>	<p>Thirty trials included patients undergoing abdominal surgery [20],[21],[22],[23],[24],[25],[26],[27],[28],[29],[30],[31],[32],[33],[34],[35],[36],[37],[38],[39],[40],[41],[42],[43],[44],[45],[46],[47],[48],[49], 16 trials patients undergoing pelvic or gynecological surgery [50],[51],[52],[53],[54],[55],[56],[57],[58],[59],[60],[61],[62],[63],[64],[65], eight trials patients undergoing orthopedic surgery [20],[66],[67],[68],[69],[70],[71],[72], seven trials patients undergoing thoracic surgery [20],[21],[73],[74],[75],[76],[77] and five trials patients undergoing other types of surgeries [78],[79],[80],[81],[82]. The remaining trials did not report the type of surgery.</p>
<p>What types of interventions were included*</p>	<p>All of the trials used intravenous ketamine. In 33 trials ketamine was administered in bolus [21],[22],[25],[26],[27],[32],[33],[35],[38],[39],[41],[44],[50],[51],[52],[53],[54],[55],[57],[59],[60],[61],[62],[66],[67],[87],[88],[90],[94],[96],[102],[124], in nine in continuous infusion [49],[58],[74],[76],[81],[85],[93],[100],[119], whereas in 35 trials both types of administration were used [20],[23],[29],[30],[31],[34],[36],[37],[40],[43],[45],[46],[48],[56],[63],[69],[70],[71],[72],[73],[75],[78],[79],[80],[82],[84],[86],[89],[91],[107],[112],[116],[121],[122],[125]. Route of administration was not reported in the remaining 35 trials. Ketamine was given during the preoperative period in 16 trials [21],[22],[25],[33],[40],[50],[54],[55],[59],[61],[66],[68],[102],[115],[119],[124], intraoperative in 21 trials [23],[29],[36],[41],[43],[44],[48],[49],[56],[64],[74],[79],[80],[86],[87],[90],[94],[97],[98],[107],[121], postoperative in 14 trials [24],[32],[35],[45],[52],[58],[78],[85],[91],[93],[110],[112],[114],[126], in two trials it was administered both pre and intraoperatively [77],[116], in three trials during preoperative and postoperative phase [38],[67],[89], in 16 trials intraoperatively and then postoperatively [20],[30],[31],[34],[37],[46],[63],[69],[70],[71],[72],[75],[81],[84],[122],[125], in two trials preoperatively and then intraoperatively and postoperatively [63],[117], and in the rest it was not reported The doses ranged from 0.05 mg to 2 mg/kg for bolus, and 0.002 to 1 mg/kg/hour for continuous infusion. Thirty-three trials reported coadministration of opioids [22],[25],[27],[31],[32],[33],[35],[36],[38],[40],[44],[45],[46],[50],[54],[56],[58],[59],[63],[66],[67],[68],[71],[78],[79],[80],[82],[88],[89],[94],[98],[119],[124]. Sixty-two trials compared to placebo [20],[21],[23],[25],[26],[29],[31],[32],[34],[35],[37],[38],[39],[41],[43],[44],[45],[46],[48],[49],[50],[51],[53],[55],[56],[58],[60],[61],[64],[66],[67],[68],[69],[70],[71],[72],[73],[74],[75],[76],[78],[79],[80],[81],[82],[84],[85],[89],[93],[94],[96],[98],[100],[102],[107],[112],[116],[119],[121],[122],[124],[125], 13 trials compared against other drugs, especially opioids [22],[33],[36],[40],[52],[54],[57],[59],[62],[63],[88],[91],[96] and it was not reported in the rest of the trials.</p>
<p>What types of outcomes were measured</p>	<p>The trials reported multiple outcomes, however they were grouped but the different systematic reviews as follows: postoperative pain, perioperative consumption of analgesia (opioids and others), time to need of first analgesic, surgical time, anesthesia time, postoperative nausea and vomiting and other adverse effects (such as unpleasant dreams, cognitive and psychological effects, hypotension and chills).</p>

* The information about primary studies is extracted from the systematic reviews identified, unless otherwise specified.

Summary of findings

It was not possible to extract sufficient information from the reviews identified as to rebuild the meta-analysis and the summary of findings table. Therefore, the information presented is based on the separate conclusions of the nine systematic reviews that performed meta-analyses for some of the outcomes of interest [5],[6],[7],[10],[11],[14],[16],[19]; pain at 24 hours after surgery [5],[6],[7],[10],[11],[16], postoperative nausea and vomiting [5],[6],[7],[10],[11],[16],[19] and sedation [9],[10],[14].

- Intravenous ketamine probably has little or no effect in reducing postoperative pain. The certainty of the evidence is moderate.
- It is not clear whether intravenous ketamine is associated to postoperative nausea and vomiting, because the certainty of the evidence is very low.
- Intravenous ketamine probably does not increase postoperative sedation. The certainty of the evidence is moderate.

Ketamine for the management of postoperative pain		
Patients	Patients undergoing surgery with general or neuroaxial anesthesia.	
Intervention	Intravenous ketamine	
Comparison	Placebo or other analgesic agents.	
Outcomes	Effects	Certainty of the evidence (GRADE)
Postoperative pain at 24-hours	The different systematic reviews concluded ketamine does not have an effect [7], [11], or it produces minimal pain reduction (0.7 to 1.3 mm in 0-100 mm visual analogue scale) [5], [6], [10], [16].	⊕⊕⊕⊕ ^{1 2} Moderate
Postoperative nausea and vomiting	The different systematic reviews did not find difference [6], [7], [11], [16], [19] or concluded they were less with ketamine [5], [10].	⊕○○○ ^{1 2} Very low
Sedation	There were no differences in sedation between the different groups [9], [10], [14].	⊕⊕⊕○ ² Moderate
GRADE: evidence grades of the GRADE Working Group (see later in this article)		
1.- The certainty of evidence was reduced in one level for pain and in two for nausea and vomiting given the inconsistency of the results obtained.		
2.- The certainty of the evidence was reduced in one level for risk bias in the primary studies. It was not decreased for pain since the bias would favor the conclusion.		

About the certainty of the evidence (GRADE)*

⊕⊕⊕⊕

High: This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different† is low.

⊕⊕⊕○

Moderate: This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different† is moderate

⊕⊕○○

Low: This research provides some indication of the likely effect. However, the likelihood that it will be substantially different† is high.

⊕○○○

Very low: This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different† is very high.

*This concept is also called 'quality of the evidence' or 'confidence in effect estimates'.

† Substantially different = a large enough difference that it might affect a decision.

Other considerations for decision-making

To whom this evidence does and does not apply

- The evidence presented in this summary are applicable to adults patients undergoing abdominal, traumatological, thoracic, pelvic or gynecological surgeries, with general or neuraxial anesthesia.
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About the outcomes included in this summary

- The outcomes presented are those considered as critical for decision-making by the authors of this summary. They coincide in general with those used by the identified systematic reviews.
-

Balance between benefits and risks, and certainty of the evidence

- It is an intervention that probably has no benefit, so it does not correspond to estimate a benefits/risk balance.
-

What would patients and their doctors think about this intervention

- In view of the evidence presented in this summary, most clinicians should lean against its use.
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Resource considerations

- It is an intervention that probably has no benefits, so it does not correspond to estimate a balance between benefits and costs.
-

Differences between this summary and other sources

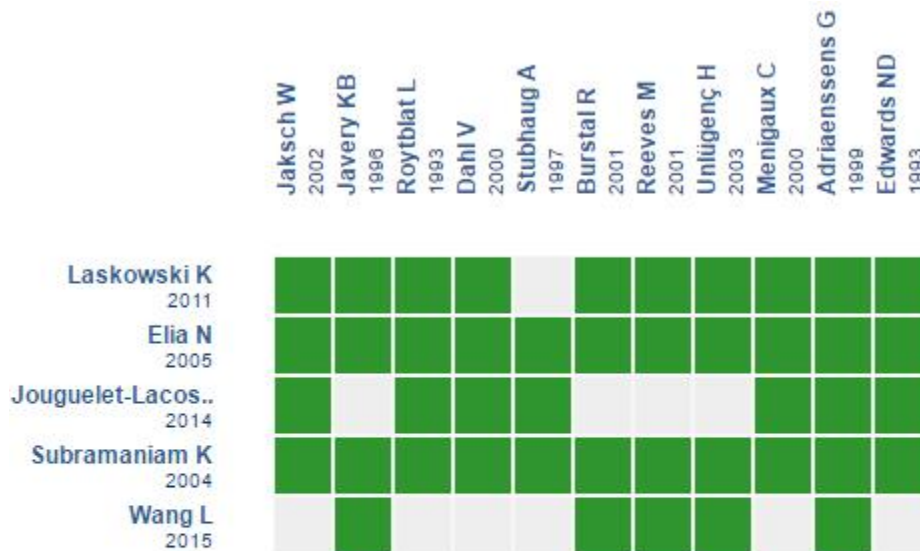
- The systematic reviews identified differ in their conclusions. One of the main reasons is they incorporate a low proportion of the trials identified in this summary.
 - The main clinical guidelines also provide discordant recommendations. For example, the Practice Guidelines for Acute Pain Management in the Perioperative Setting [246] of the American Society of Anesthesiologists do not make an explicit statement about the use of ketamine as analgesic adjuvant; the guideline of the Australian and New Zealand College of Anaesthetists [247] recommends intravenous ketamine for pain reduction, postoperative nausea and vomiting reduction, and reduction of time to first analgesia request, especially in patients undergoing thoracic, upper abdominal and orthopedic surgery. It should be noted that this guideline is mainly based on only one systematic review identified in this summary [10].
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Could this evidence change in the future?

- The likelihood that future evidence changes the conclusion of this summary is low, due to the certainty of the evidence.
 - A search in the International Clinical Trial Registry Platform of the World Health Organization did not retrieve ongoing trials addressing this question. In a PubMed search we identified at least three [248],[249],[250] randomized trials that are not included in the identified systematic reviews.
 - Considering the abundance of trials found, the scarce coverage of existing systematic reviews and the methodological limitations of these, it is very likely that a new systematic review with rigorous methods of identification and analysis could bring new insights on this topic.
 - In a search in the Prospective register of systematic reviews (PROSPERO), we did not identify any ongoing review addressing this question.
-

How we conducted this summary

Using automated and collaborative means, we compiled all the relevant evidence for the question of interest and we present it as a matrix of evidence.



Starting from any systematic review, Epistemonikos builds a matrix based on existing connections in the database.

The author of the matrix can select relevant information for a specific health question (typically in PICO format) in order to display the information set for the question.

The rows represent systematic reviews that share at least one primary study, and columns display the studies.

The boxes in green correspond to studies included in the respective reviews.

Follow the link to access the **interactive version**: [Ketamine for postoperative pain](#)

Notes

The upper portion of the matrix of evidence will display a warning of “new evidence” if new systematic reviews are published after the publication of this summary. Even though the project considers the periodical update of these summaries, users are invited to comment in *Medwave* or to contact the authors through email if they find new evidence and the summary should be updated earlier. After creating an account in Epistemonikos, users will be able to save the matrices and to receive automated notifications any time new evidence potentially relevant for the question appears.

The details about the methods used to produce these summaries are described here <http://dx.doi.org/10.5867/medwave.2014.06.5997>.

Epistemonikos foundation is a non-for-profit organization aiming to bring information closer to health decision-makers with technology. Its main development is Epistemonikos database (www.epistemonikos.org).

These summaries follow a rigorous process of internal peer review.

Conflicts of interest

The authors do not have relevant interests to declare.

Referencias

1. Ansermino M, Basu R, Vandebek C, Montgomery C. Nonopioid additives to local anaesthetics for caudal blockade in children: a systematic review. *Paediatr Anaesth*. 2003 Sep;13(7):561-73. | [PubMed](#) |
2. Carstensen M, Møller AM. Adding ketamine to morphine for intravenous patient-controlled analgesia for acute postoperative pain: a qualitative review of randomized trials. *Br J Anaesth*. 2010 Apr;104(4):401-6 | [CrossRef](#) | [PubMed](#) |
3. Cho HK, Kim KW, Jeong YM, Lee HS, Lee YJ, Hwang SH. Efficacy of ketamine in improving pain after tonsillectomy in children: meta-analysis. *PLoS One*. 2014 Jun 30;9(6):e101259. | [CrossRef](#) | [PubMed](#) |

4. Dahmani S, Michelet D, Abback PS, Wood C, Brasher C, Nivoche Y, et al. Ketamine for perioperative pain management in children: a meta-analysis of published studies. *Paediatr Anaesth.* 2011 Jun;21(6):636-52. | [CrossRef](#) | [PubMed](#) |
5. Ding X, Jin S, Niu X, Wang T, Zhao X, Ren H, et al. Morphine with adjuvant ketamine versus higher dose of morphine alone for acute pain: a meta-analysis. *Int J Clin Exp Med.* 2014 Sep 15;7(9):2504-10 | [PubMed](#) |
6. Elia N, Tramèr MR. Ketamine and postoperative pain--a quantitative systematic review of randomised trials. *Pain.* 2005 Jan;113(1-2):61-70 | [PubMed](#) |
7. Heesen M, Böhmer J, Brinck EC, Kontinen VK, Klöhr S, Rossaint R, et al. Intravenous ketamine during spinal and general anaesthesia for caesarean section: systematic review and meta-analysis. *Acta Anaesthesiol Scand.* 2015 Apr;59(4):414-26. | [CrossRef](#) | [PubMed](#) |
8. Humble SR, Dalton AJ, Li L. A systematic review of therapeutic interventions to reduce acute and chronic post-surgical pain after amputation, thoracotomy or mastectomy. *Eur J Pain.* 2015 Apr;19(4):451-65 | [CrossRef](#) | [PubMed](#) |
9. Jouguelet-Lacoste J, La Colla L, Schilling D, Chelly JE. The use of intravenous infusion or single dose of low-dose ketamine for postoperative analgesia: a review of the current literature. *Pain Med.* 2015 Feb;16(2):383-403 | [CrossRef](#) | [PubMed](#) |
10. Laskowski K, Stirling A, McKay WP, Lim HJ. A systematic review of intravenous ketamine for postoperative analgesia. *Can J Anaesth.* 2011 Oct;58(10):911-23 | [CrossRef](#) | [PubMed](#) |
11. Liu Y, Zheng Y, Gu X, Ma Z. The efficacy of NMDA receptor antagonists for preventing remifentanil-induced increase in postoperative pain and analgesic requirement: a meta-analysis. *Minerva Anesthesiol.* 2012 Jun;78(6):653-67 | [PubMed](#) |
12. McCartney CJ, Sinha A, Katz J. A qualitative systematic review of the role of N-methyl-D-aspartate receptor antagonists in preventive analgesia. *Anesth Analg.* 2004 May;98(5):1385-400 | [PubMed](#) |
13. McNicol ED, Schumann R, Haroutounian S. A systematic review and meta-analysis of ketamine for the prevention of persistent post-surgical pain. *Acta Anaesthesiol Scand.* 2014 Nov;58(10):1199-213 | [CrossRef](#) | [PubMed](#) |
14. Schmid RL, Sandler AN, Katz J. Use and efficacy of low-dose ketamine in the management of acute postoperative pain: a review of current techniques and outcomes. *Pain.* 1999 Aug;82(2):111-25 | [PubMed](#) |
15. Schnabel A, Poepping DM, Kranke P, Zahn PK, Pogatzki-Zahn EM. Efficacy and adverse effects of ketamine as an additive for paediatric caudal anaesthesia: a quantitative systematic review of randomized controlled trials. *Br J Anaesth.* 2011 Oct;107(4):601-11 | [CrossRef](#) | [PubMed](#) |
16. Subramaniam K, Subramaniam B, Steinbrook RA. Ketamine as adjuvant analgesic to opioids: a quantitative and qualitative systematic review. *Anesth Analg.* 2004 Aug;99(2):482-95 | [PubMed](#) |
17. Tong Y, Ding XB, Wang X, Ren H, Chen ZX, Li Q. Ketamine peritonsillar infiltration during tonsillectomy in pediatric patients: An updated meta-analysis. *Int J Pediatr Otorhinolaryngol.* 2014 Oct;78(10):1735-41 | [CrossRef](#) | [PubMed](#) |
18. Wang L, Johnston B, Kaushal A, Cheng D, Zhu F, Martin J. Ketamine added to morphine or hydromorphone patient-controlled analgesia for acute postoperative pain in adults: a systematic review and meta-analysis of randomized trials. *Can J Anaesth.* 2016 Mar;63(3):311-25 | [CrossRef](#) | [PubMed](#) |
19. Yang L, Zhang J, Zhang Z, Zhang C, Zhao D, Li J. Preemptive analgesia effects of ketamine in patients undergoing surgery. A meta-analysis. *Acta Cir Bras.* 2014 Dec;29(12):819-25 | [CrossRef](#) | [PubMed](#) |
20. Dualé C, Sibaud F, Guastella V, Vallet L, Gimbert YA, Taheri H, et al. Perioperative ketamine does not prevent chronic pain after thoracotomy. *Eur J Pain.* 2009 May;13(5):497-505 | [CrossRef](#) | [PubMed](#) |
21. Dullenkopf A, et al. "An Intraoperative Pre-Incision Single Dose of Intravenous Ketamine Does Not Have an Effect on Postoperative Analgesic Requirements under Clinical Conditions." *Anaesthesia and Intensive Care* 37 (2007): 753–757 | [Link](#) |
22. Papaziogas B, Argiriadou H, Papagiannopoulou P, Pavlidis T, Georgiou M, Sfyra E, et al. Preincisional intravenous low-dose ketamine and local infiltration with ropivacaine reduces postoperative pain after laparoscopic cholecystectomy. *Surg Endosc.* 2001 Sep;15(9):1030-3 | [PubMed](#) |
23. Parikh B, Maliwad J, Shah VR. Preventive analgesia: Effect of small dose of ketamine on morphine requirement after renal surgery. *J Anaesthesiol Clin Pharmacol.* 2011 Oct;27(4):485-8 | [CrossRef](#) | [PubMed](#) |
24. Pirim A, Karaman S, Uyar M, Certug A. [Addition of ketamine infusion to patient controlled analgesia with intravenous morphine after abdominal hysterectomy]. *Agri.* 2006 Jan;18(1):52-8 | [PubMed](#) |
25. Roytblat L, Korotkoruchko A, Katz J, Glazer M, Greemberg L, Fisher A. Postoperative pain: the effect of low-dose ketamine in addition to general anesthesia. *Anesth Analg.* 1993 Dec;77(6):1161-5 | [PubMed](#) |
26. Safavi M, Honarmand A, Nematollahy Z. Pre-incisional analgesia with intravenous or subcutaneous infiltration of ketamine reduces postoperative pain in patients after open cholecystectomy: a randomized, double-blind, placebo-controlled study. *Pain Med.* 2011 Sep;12(9):1418-26 | [CrossRef](#) | [PubMed](#) |
27. Sahin, A et al. "Bolus Ketamine Does Not Decrease Hyperalgesia after Remifentanil Infusion." *The Pain Clinic* 16.4 (2004): 407–411 | [Link](#) |
28. Sami Mebazaa M, Mestiri T, Kaabi B, Ben Ammar MS. Clinical benefits related to the combination of ketamine with morphine for patient controlled analgesia after major abdominal surgery. *Tunis Med.* 2008 May;86(5):435-40 | [PubMed](#) |
29. Sen H, Sizlan A, Yanarates O, Senol MG, Inangil G, Sücüllü I, Ozkan S, Dagli G. The effects of gabapentin on acute and chronic pain after inguinal herniorrhaphy. *Eur J Anaesthesiol.* 2009 Sep;26(9):772-6 | [CrossRef](#) | [PubMed](#) |
30. Stessel B, Ovink JK, Theunissen HM, Kessels AG, Marcus MA, Gramke H. Is S-ketamine with or without

- magnesium sulphate an alternative for postoperative pain treatment? Randomised study. *Eur J Anaesthesiol*. 2013 Feb;30(2):91-3 | [CrossRef](#) | [PubMed](#) |
31. Stubhaug A, Breivik H, Eide PK, Kreunen M, Foss A. Mapping of punctuate hyperalgesia around a surgical incision demonstrates that ketamine is a powerful suppressor of central sensitization to pain following surgery. *Acta Anaesthesiol Scand*. 1997 Oct;41(9):1124-32 | [PubMed](#) |
 32. Suzuki M, Tsueda K, Lansing PS, Tolan MM, Fuhrman TM, Ignacio CI, et. Small-dose ketamine enhances morphine-induced analgesia after outpatient surgery. *Anesth Analg*. 1999 Jul;89(1):98-103 | [PubMed](#) |
 33. Tverskoy M, Oz Y, Isakson A, Finger J, Bradley EL Jr, Kissin I. Preemptive effect of fentanyl and ketamine on postoperative pain and wound hyperalgesia. *Anesth Analg*. 1994 Feb;78(2):205-9 | [PubMed](#) |
 34. Webb AR, Skinner BS, Leong S, Kolawole H, Crofts T, Taverner M, et al. The addition of a small-dose ketamine infusion to tramadol for postoperative analgesia: a double-blinded, placebo-controlled, randomized trial after abdominal surgery. *Anesth Analg*. 2007 Apr;104(4):912-7 | [PubMed](#) |
 35. Weinbroum AA. A single small dose of postoperative ketamine provides rapid and sustained improvement in morphine analgesia in the presence of morphine-resistant pain. *Anesth Analg*. 2003 Mar;96(3):789-95 | [PubMed](#) |
 36. Wilder-Smith OH, Arendt-Nielsen L, Gäumann D, Tassonyi E, Rifat KR. Sensory changes and pain after abdominal hysterectomy: a comparison of anesthetic supplementation with fentanyl versus magnesium or ketamine. *Anesth Analg*. 1998 Jan;86(1):95-101 | [PubMed](#) |
 37. Zakine J, Samarcq D, Lorne E, Moubarak M, Montravers P, Beloucif S, et al. Postoperative ketamine administration decreases morphine consumption in major abdominal surgery: a prospective, randomized, double-blind, controlled study. *Anesth Analg*. 2008 Jun;106(6):1856-61 | [CrossRef](#) | [PubMed](#) |
 38. Mathisen LC, Aasbø V, Raeder J. Lack of pre-emptive analgesic effect of (R)-ketamine in laparoscopic cholecystectomy. *Acta Anaesthesiol Scand*. 1999 Feb;43(2):220-4 | [PubMed](#) |
 39. Neseek-Adam V, Grizelj-Stojcic E, Mršic V, Rašic Z, Schwarz D. Preemptive use of diclofenac in combination with ketamine in patients undergoing laparoscopic cholecystectomy: a randomized, double-blind, placebo-controlled study. *Surg Laparosc Endosc Percutan Tech*. 2012 Jun;22(3):232-8 | [CrossRef](#) | [PubMed](#) |
 40. Owen H, Reekie RM, Clements JA, Watson R, Nimmo WS. Analgesia from morphine and ketamine. A comparison of infusions of morphine and ketamine for postoperative analgesia. *Anaesthesia*. 1987 Oct;42(10):1051-6 | [PubMed](#) |
 41. Kafali H, Aldemir B, Kaygusuz K, Gürsoy S, Kunt N. Small-dose ketamine decreases postoperative morphine requirements. *Eur J Anaesthesiol*. 2004 Nov;21(11):916-7 | [PubMed](#) |
 42. Karaman S, Kocabas S, Zincircioglu C, Firat V. [Has ketamine preemptive analgesic effect in patients undergoing abdominal hysterectomy?]. *Agri*. 2006 Jul;18(3):36-44 | [PubMed](#) |
 43. Kararmaz A, Kaya S, Karaman H, Turhanoglu S, Ozyilmaz MA. Intraoperative intravenous ketamine in combination with epidural analgesia: postoperative analgesia after renal surgery. *Anesth Analg*. 2003 Oct;97(4):1092-6 | [PubMed](#) |
 44. Launo C, Bassi C, Spagnolo L, Badano S, Ricci C, Lizzi A, et. Preemptive ketamine during general anesthesia for postoperative analgesia in patients undergoing laparoscopic cholecystectomy. *Minerva Anesthesiol*. 2004 Oct;70(10):727-34; 734-8 | [PubMed](#) |
 45. Joachimsson PO, Hedstrand U, Eklund A. Low-dose ketamine infusion for analgesia during postoperative ventilator treatment. *Acta Anaesthesiol Scand*. 1986 Nov;30(8):697-702 | [PubMed](#) |
 46. Ilkjaer S, Nikolajsen L, Hansen TM, Wernberg M, Brennum J, Dahl JB. Effect of i.v. ketamine in combination with epidural bupivacaine or epidural morphine on postoperative pain and wound tenderness after renal surgery. *Br J Anaesth*. 1998 Nov;81(5):707-12 | [PubMed](#) |
 47. Joly V, Richebe P, Guignard B, Fletcher D, Maurette P, Sessler DI, et al. Remifentanyl-induced postoperative hyperalgesia and its prevention with small-dose ketamine. *Anesthesiology*. 2005 Jul;103(1):147-55 | [PubMed](#) |
 48. Fu ES, Miguel R, Scharf JE. Preemptive ketamine decreases postoperative narcotic requirements in patients undergoing abdominal surgery. *Anesth Analg*. 1997 May;84(5):1086-90 | [PubMed](#) |
 49. Guillou N, Tanguy M, Seguin P, Branger B, Campion JP, Mallédant Y. The effects of small-dose ketamine on morphine consumption in surgical intensive care unit patients after major abdominal surgery. *Anesth Analg*. 2003 Sep;97(3):843-7 | [PubMed](#) |
 50. Lehmann KA, Klaschik M. [Lack of pre-emptive analgesic effect of low-dose ketamine in postoperative patients. A prospective, randomized double-blind study]. *Schmerz*. 2001 Aug;15(4):248-53 | [PubMed](#) |
 51. Lenzmeier B, Moore RL, Cordts P, Garrett N. Menstrual cycle-related variations in postoperative analgesia with the preemptive use of N-methyl D-aspartate antagonist ketamine: a pilot study. *Dimens Crit Care Nurs*. 2008 Nov-Dec;27(6):271-6 | [CrossRef](#) | [PubMed](#) |
 52. Maurset A, Skoglund LA, Hustveit O, Oye I. Comparison of ketamine and pethidine in experimental and postoperative pain. *Pain*. 1989 Jan;36(1):37-41 | [PubMed](#) |
 53. Menkiti ID, Desalu I, Kushimo OT. Low-dose intravenous ketamine improves postoperative analgesia after caesarean delivery with spinal bupivacaine in African parturients. *Int J Obstet Anesth*. 2012 Jul;21(3):217-21 | [CrossRef](#) | [PubMed](#) |
 54. Ngan Kee WD, Khaw KS, Ma ML, Mainland PA, Gin T. Postoperative analgesic requirement after cesarean section: a comparison of anesthetic induction with ketamine or thiopental. *Anesth Analg*. 1997 Dec;85(6):1294-8 | [PubMed](#) |
 55. Reza FM, Zahra F, Esmaeel F, Hossein A. Preemptive analgesic effect of ketamine in patients undergoing

- elective cesarean section. *Clin J Pain*. 2010 Mar-Apr;26(3):223-6 | [CrossRef](#) | [PubMed](#) |
56. Katz J, Schmid R, Snijdelaar DG, Coderre TJ, McCartney CJ, Wowk A. Pre-emptive analgesia using intravenous fentanyl plus low-dose ketamine for radical prostatectomy under general anesthesia does not produce short-term or long-term reductions in pain or analgesic use. *Pain*. 2004 Aug;110(3):707-18 | [PubMed](#) |
 57. Sen S, Ozmert G, Aydin ON, Baran N, Caliskan E. The persisting analgesic effect of low-dose intravenous ketamine after spinal anaesthesia for caesarean section. *Eur J Anaesthesiol*. 2005 Jul;22(7):518-23 | [PubMed](#) |
 58. Suppa E, Valente A, Catarci S, Zanfini BA, Draisci G. A study of low-dose S-ketamine infusion as "preventive" pain treatment for cesarean section with spinal anesthesia: benefits and side effects. *Minerva Anesthesiol*. 2012 Jul;78(7):774-81 | [PubMed](#) |
 59. Wanna O, Werawatganon T, Piriyaakitphaiboon S, Taesiri B. A comparison of propofol and ketamine as induction agents for cesarean section. *J Med Assoc Thai*. 2004 Jul;87 (7):774-9 | [PubMed](#) |
 60. Kose EA, Honca M, Dal D, Akinci SB, Aypar U. Prophylactic ketamine to prevent shivering in parturients undergoing Cesarean delivery during spinal anesthesia. *J Clin Anesth*. 2013 Jun;25(4):275-80 | [CrossRef](#) | [PubMed](#) |
 61. Kwok RF, Lim J, Chan MT, Gin T, Chiu WK. Preoperative ketamine improves postoperative analgesia after gynecologic laparoscopic surgery. *Anesth Analg*. 2004 Apr;98 (4):1044-9 | [PubMed](#) |
 62. Lauretti GR, Azevedo VM. Intravenous ketamine or fentanyl prolongs postoperative analgesia after intrathecal neostigmine. *Anesth Analg*. 1996 Oct;83(4):766-70 | [PubMed](#) |
 63. Heinke W, Grimm D. [Preemptive effects caused by co-analgesia with ketamine in gynecological laparotomies?]. *Anesthesiol Reanim*. 1999;24(3):60-4 | [PubMed](#) |
 64. Hajipour, A. "Effects of Preemptive Ketamine on Post-Cesarean Analgesic Requirement." *Acta Medica Iranica* 40.2 (2002): 100-103 | [Link](#) |
 65. Han SY, Jin HC, Yang WD, Lee JH, Cho SH, Chae WS, Lee JS, Kim YI. The Effect of Low-dose Ketamine on Post-caesarean Delivery Analgesia after Spinal Anesthesia. *Korean J Pain*. 2013 Jul;26(3):270-6 | [CrossRef](#) | [PubMed](#) |
 66. Kudoh A, Takahira Y, Katagai H, Takazawa T. Small-dose ketamine improves the postoperative state of depressed patients. *Anesth Analg*. 2002 Jul;95(1):114-8 | [PubMed](#) |
 67. Menigaux C, Fletcher D, Dupont X, Guignard B, Guirimand F, Chauvin M. The benefits of intraoperative small-dose ketamine on postoperative pain after anterior cruciate ligament repair. *Anesth Analg*. 2000 Jan;90(1):129-35 | [PubMed](#) |
 68. Menigaux C, Guignard B, Fletcher D, Sessler DI, Dupont X, Chauvin M. Intraoperative small-dose ketamine enhances analgesia after outpatient knee arthroscopy. *Anesth Analg*. 2001 Sep;93(3):606-12 | [PubMed](#) |
 69. Subramaniam K, Akhouri V, Glazer PA, Rachlin J, Kunze L, Cronin M, et al. Intra- and postoperative very low dose intravenous ketamine infusion does not increase pain relief after major spine surgery in patients with preoperative narcotic analgesic intake. *Pain Med*. 2011 Aug;12(8):1276-83 | [CrossRef](#) | [PubMed](#) |
 70. Urban MK, Ya Deau JT, Wukovits B, Lipnitsky JY. Ketamine as an adjunct to postoperative pain management in opioid tolerant patients after spinal fusions: a prospective randomized trial. *HSS J*. 2008 Feb;4(1):62-5 | [CrossRef](#) | [PubMed](#) |
 71. Jaksch W, Lang S, Reichhalter R, Raab G, Dann K, Fitzal S. Perioperative small-dose S(+)-ketamine has no incremental beneficial effects on postoperative pain when standard-practice opioid infusions are used. *Anesth Analg*. 2002 Apr;94(4):981-6 | [PubMed](#) |
 72. Kim SH, Kim SI, Ok SY, Park SY, Kim MG, Lee SJ, Noh JI, Chun HR, Suh H. Opioid sparing effect of low dose ketamine in patients with intravenous patient-controlled analgesia using fentanyl after lumbar spinal fusion surgery. *Korean J Anesthesiol*. 2013 Jun;64(6):524-8 | [CrossRef](#) | [PubMed](#) |
 73. Hayes C, Armstrong-Brown A, Burstal R. Perioperative intravenous ketamine infusion for the prevention of persistent post-amputation pain: a randomized, controlled trial. *Anaesth Intensive Care*. 2004 Jun;32(3):330-8 | [PubMed](#) |
 74. Joseph C, Gaillat F, Duponq R, Lieven R, Baumstarck K, Thomas P, et al. Is there any benefit to adding intravenous ketamine to patient-controlled epidural analgesia after thoracic surgery? A randomized double-blind study. *Eur J Cardiothorac Surg*. 2012 Oct;42(4):e58-65 | [CrossRef](#) | [PubMed](#) |
 75. Lahtinen P, Kokki H, Hakala T, Hynynen M. S(+)-ketamine as an analgesic adjunct reduces opioid consumption after cardiac surgery. *Anesth Analg*. 2004 Nov;99(5):1295-301 | [PubMed](#) |
 76. Mendola C, Cammarota G, Netto R, Cecci G, Pisterna A, Ferrante D, et al. S+ -ketamine for control of perioperative pain and prevention of post thoracotomy pain syndrome: a randomized, double-blind study. *Minerva Anesthesiol*. 2012 Jul;78(7):757-66 | [PubMed](#) |
 77. Ögün CÖ, Duman A, Ökesli S. "The Comparison of Postoperative Analgesic Effects of Preemptive Ketamine and Fentanyl Use in Mastectomy Operations." *The journal of the Turkish Society of Algology* 13.2 (2001): 31-40. Web. 7 May 2016 | [Link](#) |
 78. Edwards ND, Fletcher A, Cole JR, Peacock JE. Combined infusions of morphine and ketamine for postoperative pain in elderly patients. *Anaesthesia*. 1993 Feb;48(2):124-7 | [PubMed](#) |
 79. Ganne O, Abisseror M, Menault P, Malhière S, Chambost V, Charpiat B, Ganne C, Viale JP. Low-dose ketamine failed to spare morphine after a remifentanyl-based anaesthesia for ear, nose and throat surgery. *Eur J Anaesthesiol*. 2005 Jun;22(6):426-30. | [PubMed](#) |
 80. Guignard B, Coste C, Costes H, Sessler DI, Lebrault C, Morris W, Simonnet G, Chauvin M. Supplementing desflurane-remifentanyl anesthesia with small-dose ketamine reduces perioperative opioid analgesic requirements. *Anesth Analg*. 2002 Jul;95(1):103-8, table of contents | [PubMed](#) |

81. Hadi BA, Daas R, Zekó R. "A Randomized, Controlled Trial of a Clinical Pharmacist Intervention in Microdiscectomy Surgery - Low Dose Intravenous Ketamine as an Adjunct to Standard Therapy." *Saudi pharmaceutical journal : SPJ : the official publication of the Saudi Pharmaceutical Society* 21.2 (2013): 169-175 | [Link](#) |
82. Van Elstraete AC, Lebrun T, Sandefo I, Polin B. Ketamine does not decrease postoperative pain after remifentanyl-based anaesthesia for tonsillectomy in adults. *Acta Anaesthesiol Scand.* 2004 Jul;48(6):756-60 | [PubMed](#) |
83. Abu-Shahwan I. Ketamine does not reduce postoperative morphine consumption after tonsillectomy in children. *Clin J Pain.* 2008 Jun;24(5):395-8 | [CrossRef](#) | [PubMed](#) |
84. Adam F, Chauvin M, Du Manoir B, Langlois M, Sessler DI, Fletcher D. Small-dose ketamine infusion improves postoperative analgesia and rehabilitation after total knee arthroplasty. *Anesth Analg.* 2005 Feb;100(2):475-80 | [PubMed](#) |
85. Adriaenssens G, Vermeyen KM, Hoffmann VL, Mertens E, Adriaensen HF. Postoperative analgesia with i.v. patient-controlled morphine: effect of adding ketamine. *Br J Anaesth.* 1999 Sep;83(3):393-6 | [PubMed](#) |
86. Aida S, Yamakura T, Baba H, Taga K, Fukuda S, Shimoji K. Preemptive analgesia by intravenous low-dose ketamine and epidural morphine in gastrectomy: a randomized double-blind study. *Anesthesiology.* 2000 Jun;92(6):1624-30 | [PubMed](#) |
87. Argiriadou H, Himmelseher S, Papagiannopoulou P, Georgiou M, Kanakoudis F, Giala M, et al. Improvement of pain treatment after major abdominal surgery by intravenous S+-ketamine. *Anesth Analg.* 2004 May;98(5):1413-8 | [PubMed](#) |
88. Arroyo-Novoa CM, Figueroa-Ramos MI, Miaskowski C, Padilla G, Paul SM, Rodríguez-Ortiz P, et al. Efficacy of small doses of ketamine with morphine to decrease procedural pain responses during open wound care. *Clin J Pain.* 2011 Sep;27(7):561-6 | [CrossRef](#) | [PubMed](#) |
89. Aubrun F, Gaillat C, Rosenthal D, Dupuis M, Mottet P, Marchetti F, et al. Effect of a low-dose ketamine regimen on pain, mood, cognitive function and memory after major gynaecological surgery: a randomized, double-blind, placebo-controlled trial. *Eur J Anaesthesiol.* 2008 Feb;25(2):97-105 | [PubMed](#) |
90. Aveline C, Hetet HL, Vautier P, Gautier JF, Bonnet F. Perioperative ketamine and morphine for postoperative pain control after lumbar disk surgery. *Eur J Pain.* 2006 Oct;10(7):653-8 | [PubMed](#) |
91. Aveline C, Gautier JF, Vautier P, Cognet F, Hetet HL, Attali JY, et al. Postoperative analgesia and early rehabilitation after total knee replacement: a comparison of continuous low-dose intravenous ketamine versus nefopam. *Eur J Pain.* 2009 Jul;13(6):613-9 | [CrossRef](#) | [PubMed](#) |
92. Ayoglu H, Karadeniz U, Kunduracilar Z, Ayoglu FN, Erdemli O. "The Analgesic Effect of Magnesium Sulfate and Ketamine in Patients Undergoing Laparoscopic Cholecystectomy." *The Pain Clinic* 17.1 (2005): 45-53 | [Link](#) |
93. Barreveld AM, Correll DJ, Liu X, Max B, McGowan JA, Shovel L, et al. Ketamine decreases postoperative pain scores in patients taking opioids for chronic pain: results of a prospective, randomized, double-blind study. *Pain Med.* 2013 Jun;14(6):925-34 | [CrossRef](#) | [PubMed](#) |
94. Bauchat JR, Higgins N, Wojciechowski KG, McCarthy RJ, Toledo P, Wong CA. Low-dose ketamine with multimodal postcesarean delivery analgesia: a randomized controlled trial. *Int J Obstet Anesth.* 2011 Jan;20(1):3-9 | [CrossRef](#) | [PubMed](#) |
95. Becke K, Albrecht S, Schmitz B, Rech D, Koppert W, Schüttler J, et al. Intraoperative low-dose S-ketamine has no preventive effects on postoperative pain and morphine consumption after major urological surgery in children. *Paediatr Anaesth.* 2005 Jun;15(6):484-90 | [PubMed](#) |
96. Behdad A, Hosseinpour M, Khorasani P. Preemptive use of ketamine on post operative pain of appendectomy. *Korean J Pain.* 2011 Sep;24(3):137-40 | [CrossRef](#) | [PubMed](#) |
97. Behdad S, Hajiesmaeili MR, Abbasi HR, Ayatollahi V, Khadiv Z, Sedaghat A. Analgesic Effects of Intravenous Ketamine during Spinal Anesthesia in Pregnant Women Undergone Caesarean Section; A Randomized Clinical Trial. *Anesth Pain Med.* 2013 Sep;3(2):230-3 | [CrossRef](#) | [PubMed](#) |
98. Bilgen S, Köner O, Türe H, Menda F, Fiçioğlu C, Aykaç B. Effect of three different doses of ketamine prior to general anaesthesia on postoperative pain following Caesarean delivery: a prospective randomized study. *Minerva Anesthesiol.* 2012 Apr;78(4):442-9 | [PubMed](#) |
99. Butkovic D, Kralik S, Matolic M, Jakobovic J, Zganjer M, Radesic L. Comparison of a preincisional and postincisional small dose of ketamine for postoperative analgesia in children. *Bratisl Lek Listy.* 2007;108(4-5):184-8 | [PubMed](#) |
100. Clausen L, Sinclair DM, Van Hasselt CH. "Intravenous Ketamine for Postoperative Analgesia." *South African medical journal* 49.35 (1975): 1437-1440 | [Link](#) |
101. Colombani S, Kabbani Y, Mathoulin-Pélissier S, Gékière JP, Dixmérias F, Monnin D, et al. [Administration of ketamine during induction and maintenance of anaesthesia in postoperative pain prevention]. *Ann Fr Anesth Reanim.* 2008 Mar;27(3):202-7 | [CrossRef](#) | [PubMed](#) |
102. Dahl V, Ernoe PE, Steen T, Raeder JC, White PF. Does ketamine have preemptive effects in women undergoing abdominal hysterectomy procedures? *Anesth Analg.* 2000 Jun;90(6):1419-22 | [PubMed](#) |
103. Dal D, Celebi N, Elvan EG, Celiker V, Aypar U. The efficacy of intravenous or peritonsillar infiltration of ketamine for postoperative pain relief in children following adenotonsillectomy. *Paediatr Anaesth.* 2007 Mar;17(3):263-9 | [PubMed](#) |
104. Dal D, Kose A, Honca M, Akinci SB, Basgul E, Aypar U. Efficacy of prophylactic ketamine in preventing postoperative shivering. *Br J Anaesth.* 2005 Aug;95(2):189-92 | [PubMed](#) |

105. Darabi ME , Mireskandari SM , Sadeghi M , Salamati P , Rahimi E. "Ketamine Has No Pre-Emptive Analgesic Effect in Children Undergoing Inguinal Hernia Repair." *Acta Medica Iranica* 46.6 (2008): 451–456 | [Link](#) |
106. Darwish HM , Marzouk S , El Kholi G , El-Din WS. "Low Dose Ketamine Prevents Acute Opioid Tolerance Induced by Remifentanil Infusion." *Egyptian Journal Of Anaesthesia* 21.3 (2005): 259–266 | [Link](#) |
107. De Kock M, Lavand'homme P, Waterloos H. 'Balanced analgesia' in the perioperative period: is there a place for ketamine? *Pain*. 2001 Jun;92(3):373-80 | [PubMed](#) |
108. Deng GF, Zheng JP, Wang S, Tian B, Zhang SG. Remifentanil combined with low-dose ketamine for postoperative analgesia of lower limb fracture: a double-blind, controlled study. *Chin J Traumatol*. 2009 Aug;12(4):223-7 | [PubMed](#) |
109. Gilabert Morell A, Sánchez Pérez C. [Effect of low-dose intravenous ketamine in postoperative analgesia for hysterectomy and adnexectomy]. *Rev Esp Anestesiol Reanim*. 2002 May;49(5):247-53 | [PubMed](#) |
110. Gillies A, Lindholm D, Angliss M, Orr A. The use of ketamine as rescue analgesia in the recovery room following morphine administration--a double-blind randomised controlled trial in postoperative patients. *Anaesth Intensive Care*. 2007 Apr;35(2):199-203 | [PubMed](#) |
111. Hadi BA, Al Ramadani R, Daas R, Naylor I, Zelkó R. Remifentanil in combination with ketamine versus remifentanil in spinal fusion surgery--a double blind study. *Int J Clin Pharmacol Ther*. 2010 Aug;48(8):542-8 | [PubMed](#) |
112. Jahangir SM, Islam F, Aziz L. Ketamine infusion for postoperative analgesia in asthmatics: a comparison with intermittent meperidine. *Anesth Analg*. 1993 Jan;76(1):45-9 | [PubMed](#) |
113. Kapfer B, Alfonsi P, Guignard B, Sessler DI, Chauvin M. Nefopam and ketamine comparably enhance postoperative analgesia. *Anesth Analg*. 2005 Jan;100(1):169-74 | [PubMed](#) |
114. Lak M , Foroozanmehr MJ , Ramazani MA. "Assessment of Ketamine Effect as Adjuvant to Morphine in Post-Operative Pain Reduction in Donor Kidney Transplanted." *Iranian Red Crescent Medical Journal* 12.1 (2010): 38–44. Web. 5 May 2016 | [Link](#) |
115. Lebrun T, Van Elstraete AC, Sandefo I, Polin B, Pierre-Louis L. Lack of a pre-emptive effect of low-dose ketamine on postoperative pain following oral surgery. *Can J Anaesth*. 2006 Feb;53(2):146-52 | [PubMed](#) |
116. Loftus RW, Yeager MP, Clark JA, Brown JR, Abdu WA, Sengupta DK, et al. Intraoperative ketamine reduces perioperative opiate consumption in opiate-dependent patients with chronic back pain undergoing back surgery. *Anesthesiology*. 2010 Sep;113(3):639-46 | [CrossRef](#) | [PubMed](#) |
117. McKay WP, Donais P. Bowel function after bowel surgery: morphine with ketamine or placebo; a randomized controlled trial pilot study. *Acta Anaesthesiol Scand*. 2007 Oct;51(9):1166-71 | [PubMed](#) |
118. Michelet P, Guervilly C, Hélaïne A, Avaro JP, Blayac D, Gaillat F, et al. Adding ketamine to morphine for patient-controlled analgesia after thoracic surgery: influence on morphine consumption, respiratory function, and nocturnal desaturation. *Br J Anaesth*. 2007 Sep;99(3):396-403 | [PubMed](#) |
119. Mortero RF, Clark LD, Tolan MM, Metz RJ, Tsueda K, Sheppard RA. The effects of small-dose ketamine on propofol sedation: respiration, postoperative mood, perception, cognition, and pain. *Anesth Analg*. 2001 Jun;92(6):1465-9 | [PubMed](#) |
120. Ozgun S, Ugur B , Aydin ON , Eyigor H , Erpek G. "The Effect of Preemptive Ketamine on Analgesia and Analgesic Consumption after Tonsillectomy." *TURK ANESTEZIYOLOJİ VE REANIMASYON DERNEĞİ DERGİSİ* 31.5 (2003): 247-52 | [Link](#) |
121. Perrin SB, Purcell AN. Intraoperative ketamine may influence persistent pain following knee arthroplasty under combined general and spinal anaesthesia: a pilot study. *Anaesth Intensive Care*. 2009 Mar;37(2):248-53 | [PubMed](#) |
122. Remérand F, Le Tendre C, Baud A, Couvret C, Pourrat X, Favard L, et al. The early and delayed analgesic effects of ketamine after total hip arthroplasty: a prospective, randomized, controlled, double-blind study. *Anesth Analg*. 2009 Dec;109(6):1963-71 | [CrossRef](#) | [PubMed](#) |
123. Wu YQ, Li H, Xiong JC, Xu ZM, Ma LY, Huang XM, Zhang DT, et al. [Effects of patient-controlled analgesia with small dose ketamine combined with morphine and the influence thereof on plasma beta-endorphin level in patients after radical operation for esophageal carcinoma]. *Zhonghua Yi Xue Za Zhi*. 2009 Feb 10;89(5):314-7 | [PubMed](#) |
124. Xie H, Wang X, Liu G, Wang G. Analgesic effects and pharmacokinetics of a low dose of ketamine preoperatively administered epidurally or intravenously. *Clin J Pain*. 2003 Sep-Oct;19(5):317-22 | [PubMed](#) |
125. Yamauchi M, Asano M, Watanabe M, Iwasaki S, Furuse S, Namiki A. Continuous low-dose ketamine improves the analgesic effects of fentanyl patient-controlled analgesia after cervical spine surgery. *Anesth Analg*. 2008 Sep;107(3):1041-4 | [CrossRef](#) | [PubMed](#) |
126. Yentur EA, Topçu I, Keles G, Tasyüz T, Civi M. Subanalgesic Dose of Ketamine Added to Tramadol Does Not Reduce Analgesic Demand. *Turk J Anaesthesiol Reanim*. 2004; 32(2): 106–112. | [Link](#) |
127. Ong E Osborne GA. Ketamine for Co-Induction of Anaesthesia in Oral Surgery. *Ambul Surg*. 2001 Oct;9(3): 131–135 | [Link](#) |
128. Badrinath S, Avramov MN, Shadrack M, Witt TR, Ivankovich AD. The use of a ketamine-propofol combination during monitored anesthesia care. *Anesth Analg*. 2000 Apr;90(4):858-62 | [PubMed](#) |
129. Frey K, Sukhani R, Pawlowski J, Pappas AL, Mikat-Stevens M, Slogoff S. Propofol versus propofol-ketamine sedation for retrobulbar nerve block: comparison of sedation quality, intraocular pressure changes, and recovery profiles. *Anesth Analg*. 1999 Aug;89(2):317-21 | [PubMed](#) |

130. Gorgias NK, Maidatsi PG, Kyriakidis AM, Karakoulas KA, Alvanos DN, Giala MM. Clonidine versus ketamine to prevent tourniquet pain during intravenous regional anesthesia with lidocaine. *Reg Anesth Pain Med.* 2001 Nov-Dec;26(6):512-7 | [PubMed](#) |
131. Choudhuri AH, Dharmani P, Kumarl N, Prakash A. Comparison of caudal epidural bupivacaine with bupivacaine plus tramadol and bupivacaine plus ketamine for postoperative analgesia in children. *Anaesth Intensive Care.* 2008 Mar;36(2):174-9 | [PubMed](#) |
132. Akbas M, Akbas H, Yegin A, Sahin N, Titz TA. Comparison of the effects of clonidine and ketamine added to ropivacaine on stress hormone levels and the duration of caudal analgesia. *Paediatr Anaesth.* 2005 Jul;15(7):580-5 | [PubMed](#) |
133. Akbas M, Titz TA, Ertugrul F, Akbas H, Melikoglu M. Comparison of the effect of ketamine added to bupivacaine and ropivacaine, on stress hormone levels and the duration of caudal analgesia. *Acta Anaesthesiol Scand.* 2005 Nov;49(10):1520-6 | [PubMed](#) |
134. Moustafa AM, Negmi HH, Rabie ME. The combined effect of ketamine and remifentanyl infusions as total intravenous anesthesia for scoliosis surgery in children. *Middle East J Anaesthesiol.* 2008 Jun;19(5):1151-68 | [PubMed](#) |
135. Siddiqui AS, Raees US, Siddiqui SZ, Raza SA. Efficacy of pre-incisional peritonsillar infiltration of ketamine for post-tonsillectomy analgesia in children. *J Coll Physicians Surg Pak.* 2013 Aug;23(8):533-7 | [CrossRef](#) | [PubMed](#) |
136. Atangana R, Ngowe Ngowe M, Binam F, Sosso MA. Morphine versus morphine-ketamine association in the management of post operative pain in thoracic surgery. *Acta Anaesthesiol Belg.* 2007;58(2):125-7 | [PubMed](#) |
137. Ayatollahi V, Behdad S, Hatami M, Moshtaghiun H, Baghianimoghadam B. Comparison of peritonsillar infiltration effects of ketamine and tramadol on post tonsillectomy pain: a double-blinded randomized placebo-controlled clinical trial. *Croat Med J.* 2012 Apr;53(2):155-61 | [PubMed](#) |
138. Bazin V, Bollot J, Asehounne K, Roquilly A, Guillaud C, De Windt A, et al. Effects of perioperative intravenous low dose of ketamine on postoperative analgesia in children. *Eur J Anaesthesiol.* 2010 Jan;27(1):47-52 | [CrossRef](#) | [PubMed](#) |
139. Locatelli BG, Frawley G, Spotti A, Ingelmo P, Kaplanian S, Rossi B, et al. Analgesic effectiveness of caudal levobupivacaine and ketamine. *Br J Anaesth.* 2008 May;100(5):701-6 | [CrossRef](#) | [PubMed](#) |
140. Burstal R, Danjoux G, Hayes C, Lanry G. PCA ketamine and morphine after abdominal hysterectomy. *Anaesth Intensive Care.* 2001 Jun;29(3):246-51 | [PubMed](#) |
141. Canbay O, Celebi N, Uzun S, Sahin A, Celiker V, Aypar U. Topical ketamine and morphine for post-tonsillectomy pain. *Eur J Anaesthesiol.* 2008 Apr;25(4):287-92 | [CrossRef](#) | [PubMed](#) |
142. Chazan S, Buda I, Neshar N, Paz J, Weinbroum AA. Low-dose ketamine via intravenous patient-controlled analgesia device after various transthoracic procedures improves analgesia and patient and family satisfaction. *Pain Manag Nurs.* 2010 Sep;11(3):169-76 | [CrossRef](#) | [PubMed](#) |
143. Choe H, Choi YS, Kim YH, Ko SH, Choi HG, Han YJ, et al. Epidural morphine plus ketamine for upper abdominal surgery: improved analgesia from preincisional versus postincisional administration. *Anesth Analg.* 1997 Mar;84(3):560-3 | [PubMed](#) |
144. Murdoch CJ, Crooks BA, Miller CD. Effect of the addition of ketamine to morphine in patient-controlled analgesia. *Anaesthesia.* 2002 May;57(5):484-8 | [PubMed](#) |
145. Cook B, Grubb DJ, Aldridge LA, Doyle E. Comparison of the effects of adrenaline, clonidine and ketamine on the duration of caudal analgesia produced by bupivacaine in children. *Br J Anaesth.* 1995 Dec;75(6):698-701 | [PubMed](#) |
146. Crousier M, Cognet V, Khaled M, Gueugniaud PY, Piriou V. [Effect of ketamine on prevention of postmastectomy chronic pain. A pilot study]. *Ann Fr Anesth Reanim.* 2008 Dec;27(12):987-93 | [CrossRef](#) | [PubMed](#) |
147. Wong CS, Lu CC, Cherng CH, Ho ST. Pre-emptive analgesia with ketamine, morphine and epidural lidocaine prior to total knee replacement. *Can J Anaesth.* 1997 Jan;44(1):31-7 | [PubMed](#) |
148. Wong CS, Liaw WJ, Tung CS, Su YF, Ho ST. Ketamine potentiates analgesic effect of morphine in postoperative epidural pain control. *Reg Anesth.* 1996 Nov-Dec;21(6):534-41 | [PubMed](#) |
149. Dahi-Taleghani M, Fazli B, Ghasemi M, Vosoughian M, Dabbagh A. Effect of intravenous patient controlled ketamine analgesia on postoperative pain in opium abusers. *Anesth Pain Med.* 2014 Feb 15;4(1):e14129 | [CrossRef](#) | [PubMed](#) |
150. Dang X, Su S, Sun L, He L, Wu J. Analgesic Effect of Ketamine Adding to Morphine in Patient-Controlled Analgesia for Patients after Surgery for Femur Fracture. *Guangdong Yi Xue.* 2013;34(4): 608-611 | [CrossRef](#) |
151. Snijdelaar DG, Cornelisse HB, Schmid RL, Katz J. A randomised, controlled study of peri-operative low dose s(+)-ketamine in combination with postoperative patient-controlled s(+)-ketamine and morphine after radical prostatectomy. *Anaesthesia.* 2004 Mar;59(3):222-8 | [PubMed](#) |
152. Dix P, Martindale S, Stoddart PA. Double-blind randomized placebo-controlled trial of the effect of ketamine on postoperative morphine consumption in children following appendicectomy. *Paediatr Anaesth.* 2003 Jun;13(5):422-6 | [PubMed](#) |
153. Elhakim M, Khalafallah Z, El-Fattah HA, Farouk S, Khattab A. Ketamine reduces swallowing-evoked pain after paediatric tonsillectomy. *Acta Anaesthesiol Scand.* 2003 May;47(5):604-9 | [PubMed](#) |
154. Elshammaa N, Chidambaran V, Housny W, Thomas J, Zhang X, Michael R. Ketamine as an adjunct to fentanyl improves postoperative analgesia and hastens discharge in children following tonsillectomy - a prospective, double-blinded, randomized study. *Paediatr Anaesth.* 2011 Oct;21(10):1009-14 | [CrossRef](#) | [PubMed](#) |
155. Engelhardt T, Zaarour C, Naser B, Pehora C, de Ruitter J, Howard A, et al. Intraoperative low-dose

- ketamine does not prevent a remifentanyl-induced increase in morphine requirement after pediatric scoliosis surgery. *Anesth Analg.* 2008 Oct;107(4):1170-5 | [CrossRef](#) | [PubMed](#) |
156. Zahra FA, Abudallah HM, Shabana RI, Abdulmageed WM, Abdulrazik SI, Nassar AM. Intramuscular ketamine for prevention of postanesthesia shivering in children. *Saudi Med J.* 2008 Sep;29(9):1255-9 | [PubMed](#) |
157. Huang GS, Yeh CC, Kong SS, Lin TC, Ho ST, Wong CS. Intra-articular ketamine for pain control following arthroscopic knee surgery. *Acta Anaesthesiol Sin.* 2000 Sep;38(3):131-6 | [PubMed](#) |
158. Günes Y, Seçen M, Ozcengiz D, Gündüz M, Balcioğlu O, Isik G. Comparison of caudal ropivacaine, ropivacaine plus ketamine and ropivacaine plus tramadol administration for postoperative analgesia in children. *Paediatr Anaesth.* 2004 Jul;14(7):557-63 | [PubMed](#) |
159. Hagelin A, Lundberg D. Ketamine for postoperative analgesia after upper abdominal surgery. *Clin Ther.* 1981;4(3):229-33 | [PubMed](#) |
160. Hasnain F, Janbaz KH, Qureshi MA. Analgesic effect of ketamine and morphine after tonsillectomy in children. *Pak J Pharm Sci.* 2012 Jul;25(3):599-606 | [PubMed](#) |
161. Hercocock T, Gillham MJ, Sleigh J, Jones SF. The Addition of Ketamine to Patient Controlled Morphine Analgesia Does Not Improve Quality of Analgesia after Total Abdominal Hysterectomy. *Acute Pain.* 1999 Jun;2(2): 68-72 | [CrossRef](#) |
162. Ryu HG, Lee CJ, Kim YT, Bahk JH. Preemptive low-dose epidural ketamine for preventing chronic postthoracotomy pain: a prospective, double-blinded, randomized, clinical trial. *Clin J Pain.* 2011 May;27(4):304-8 | [CrossRef](#) | [PubMed](#) |
163. Himmelseher S, Ziegler-Pithamitsis D, Argiriadou H, Martin J, Jelen-Esselborn S, Kochs E. Small-dose S(+)-ketamine reduces postoperative pain when applied with ropivacaine in epidural anesthesia for total knee arthroplasty. *Anesth Analg.* 2001 May;92(5):1290-5 | [PubMed](#) |
164. Lee HM, Sanders GM. Caudal ropivacaine and ketamine for postoperative analgesia in children. *Anaesthesia.* 2000 Aug;55(8):806-10 | [PubMed](#) |
165. Honarmand A, Safavi MR, Jamshidi M. The preventative analgesic effect of preincisional peritonsillar infiltration of two low doses of ketamine for postoperative pain relief in children following adenotonsillectomy. A randomized, double-blind, placebo-controlled study. *Paediatr Anaesth.* 2008 Jun;18(6):508-14 | [CrossRef](#) | [PubMed](#) |
166. Honarmand A, Safavi M, Kashefi P, Hosseini B, Badii S. Comparison of effect of intravenous ketamine, peritonsillar infiltration of tramadol and their combination on pediatric posttonsillectomy pain: A double-blinded randomized placebo-controlled clinical trial. *Res Pharm Sci.* 2013 Jul;8(3):177-83 | [PubMed](#) |
167. Inanoglu K, Ozbakis Akkurt BC, Turhanoglu S, Okuyucu S, Akoglu E. Intravenous ketamine and local bupivacaine infiltration are effective as part of a multimodal regime for reducing post-tonsillectomy pain. *Med Sci Monit.* 2009 Oct;15(10):CR539-543 | [PubMed](#) |
168. Wilson JA, Nimmo AF, Fleetwood-Walker SM, Colvin LA. A randomised double blind trial of the effect of pre-emptive epidural ketamine on persistent pain after lower limb amputation. *Pain.* 2008 Mar;135(1-2):108-18 | [PubMed](#) |
169. O'Flaherty JE, Lin CX. Does ketamine or magnesium affect ostonsillectomy pain in children? *Paediatr Anaesth.* 2003 Jun;13(5):413-21 | [PubMed](#) |
170. Dich-Nielsen JO, Svendsen LB, Berthelsen P. Intramuscular low-dose ketamine versus pethidine for postoperative pain treatment after thoracic surgery. *Acta Anaesthesiol Scand.* 1992 Aug;36(6):583-7 | [PubMed](#) |
171. Kamal, Hanan Mahmoud. Ketamine as an Adjuvant to Morphine for Patient Controlled Analgesia in Morbidly Obese Patients. *J Med Sci.* 2008;8(4): 364-370. | [CrossRef](#) |
172. Kararmaz A, Kaya S, Turhanoglu S, Ozyilmaz MA. Oral ketamine premedication can prevent emergence agitation in children after desflurane anaesthesia. *Paediatr Anaesth.* 2004 Jun;14(6):477-82 | [PubMed](#) |
173. Kathirvel S, Sadhasivam S, Saxena A, Kannan TR, Ganjoo P. Effects of intrathecal ketamine added to bupivacaine for spinal anaesthesia. *Anaesthesia.* 2000 Sep;55(9):899-904 | [PubMed](#) |
174. Javery KB, Ussery TW, Steger HG, Colclough GW. Comparison of morphine and morphine with ketamine for postoperative analgesia. *Can J Anaesth.* 1996 Mar;43(3):212-5 | [PubMed](#) |
175. Khademi S, Ghaffarpasand F, Heiran HR, Yavari MJ, Motazedian S, Dehghankhalili M. Intravenous and peritonsillar infiltration of ketamine for postoperative pain after adenotonsillectomy: a randomized placebo-controlled clinical trial. *Med Princ Pract.* 2011;20(5):433-7 | [CrossRef](#) | [PubMed](#) |
176. Kirdemir P, Ozkoçak I, Demir T, Gögüs N. Comparison of postoperative analgesic effects of preemptively used epidural ketamine and neostigmine. *J Clin Anesth.* 2000 Nov;12(7):543-8 | [PubMed](#) |
177. Kollender Y, Bickels J, Stocki D, Maruoani N, Chazan S, Nirkin A, et al. Subanaesthetic ketamine spares postoperative morphine and controls pain better than standard morphine does alone in orthopaedic-oncological patients. *Eur J Cancer.* 2008 May;44(7):954-62 | [CrossRef](#) | [PubMed](#) |
178. Ugur KS, Karabayirli S, Demircioglu RI, Ark N, Kurtaran H, Muslu B, et al. The comparison of preincisional peritonsillar infiltration of ketamine and tramadol for postoperative pain relief on children following adenotonsillectomy. *Int J Pediatr Otorhinolaryngol.* 2013 Nov;77(11):1825-9 | [CrossRef](#) | [PubMed](#) |
179. Kumar P, Rudra A, Pan AK, Acharya A. Caudal additives in pediatrics: a comparison among midazolam, ketamine, and neostigmine coadministered with bupivacaine. *Anesth Analg.* 2005 Jul;101(1):69-73 | [PubMed](#) |
180. Mathisen LC, Skjelbred P, Skoglund LA, Oye I. Effect of ketamine, an NMDA receptor inhibitor, in acute

- and chronic orofacial pain. *Pain*. 1995 May;61(2):215-20 | [PubMed](#) |
181. Levänen J. Ketamine and oxycodone in the management of postoperative pain. *Mil Med*. 2000 Jun;165(6):450-5 | [PubMed](#) |
 182. Liu G, Huang Y, Luo A. Patient-Controlled Intravenous Morphine and Ketamine for Postoperative Analgesia. *Chinese Journal of Anesthesiology*. 2003;23(6): 416-418 | [Link](#) |
 183. Jensen LL, Handberg G, Helbo-Hansen HS, Skaarup I, Lohse T, Munk T, Lund N. No morphine sparing effect of ketamine added to morphine for patient-controlled intravenous analgesia after uterine artery embolization. *Acta Anaesthesiol Scand*. 2008 Apr;52(4):479-86 | [CrossRef](#) | [PubMed](#) |
 184. Lo A, Macpherson N, Spiwak R. "Prospective Randomized Trial of Patient-Controlled Analgesia with Ketamine and Morphine or Morphine Alone after Hysterectomy. *Can J Hosp Pharm*. 2008 Sep;61(5): 334-339 | [CrossRef](#) |
 185. Martinez V, Cymerman A, Ben Ammar S, Fiaud JF, Rapon C, Poindessous F, et al. The analgesic efficiency of combined pregabalin and ketamine for total hip arthroplasty: a randomised, double-blind, controlled study. *Anaesthesia*. 2014 Jan;69(1):46-52 | [CrossRef](#) | [PubMed](#) |
 186. Abdel-Ghaffar ME, Abdulatif MA, al-Ghamdi A, Mowafi H, Anwar A. Epidural ketamine reduces post-operative epidural PCA consumption of fentanyl/bupivacaine. *Can J Anaesth*. 1998 Feb;45(2):103-9 | [PubMed](#) |
 187. Eghbal MH, Taregh S, Amin A, Sahmeddini MA. Ketamine improves postoperative pain and emergence agitation following adenotonsillectomy in children. A randomized clinical trial. *Middle East J Anaesthesiol*. 2013 Jun;22(2):155-60 | [PubMed](#) |
 188. El Sonbaty MI, Abo el Dahab H, Mostafa A, Abo Shanab O. Preemptive peritonsillar ketamine infiltration: postoperative analgesic efficacy versus meperidine. *Middle East J Anaesthesiol*. 2011 Feb;21(1):43-51 | [PubMed](#) |
 189. DA Conceição MJ, Bruggemann DA Conceição D, Carneiro Leão C. Effect of an intravenous single dose of ketamine on postoperative pain in tonsillectomy patients. *Paediatr Anaesth*. 2006 Sep;16(9):962-7 | [PubMed](#) |
 190. Sadove MS, Shulman M, Hatano S, Fevold N. Analgesic effects of ketamine administered in subdissociative doses. *Anesth Analg*. 1971 May-Jun;50(3):452-7 | [PubMed](#) |
 191. Grady MV, Mascha E, Sessler DI, Kurz A. The effect of perioperative intravenous lidocaine and ketamine on recovery after abdominal hysterectomy. *Anesth Analg*. 2012 Nov;115(5):1078-84 | [CrossRef](#) | [PubMed](#) |
 192. Naguib M, Sharif AM, Seraj M, el Gammal M, Dawlatly AA. Ketamine for caudal analgesia in children: comparison with caudal bupivacaine. *Br J Anaesth*. 1991 Nov;67(5):559-64 | [PubMed](#) |
 193. Neshar N, Ekstein MP, Paz Y, Marouani N, Chazan S, Weinbroum AA. Morphine with adjuvant ketamine vs higher dose of morphine alone for immediate postthoracotomy analgesia. *Chest*. 2009 Jul;136(1):245-52 | [CrossRef](#) | [PubMed](#) |
 194. Neshar N, Serovian I, Marouani N, Chazan S, Weinbroum AA. Ketamine spares morphine consumption after transthoracic lung and heart surgery without adverse hemodynamic effects. *Pharmacol Res*. 2008 Jul;58(1):38-44 | [CrossRef](#) | [PubMed](#) |
 195. Nitta R, Goyagi T, Nishikawa T. Combination of oral clonidine and intravenous low-dose ketamine reduces the consumption of postoperative patient-controlled analgesia morphine after spine surgery. *Acta Anaesthesiol Taiwan*. 2013 Mar;51(1):14-7 | [CrossRef](#) | [PubMed](#) |
 196. Erhan OL, Göksu H, Alpay C, Bestas A. Ketamine in post-tonsillectomy pain. *Int J Pediatr Otorhinolaryngol*. 2007 May;71(5):735-9 | [PubMed](#) |
 197. Aydin ON, Ugur B, Ozgun S, Eyigor H, Copcu O. Pain prevention with intraoperative ketamine in outpatient children undergoing tonsillectomy or tonsillectomy and adenotomy. *J Clin Anesth*. 2007 Mar;19(2):115-9 | [PubMed](#) |
 198. Nafiu OO, Kolawole IK, Salam RA, Elegbe EO. Comparison of caudal ketamine with or without bupivacaine in pediatric subumbilical surgery. *J Natl Med Assoc*. 2007 Jun;99(6):670-3 | [PubMed](#) |
 199. Ozbek H, Bilen A, Ozcengiz D, Günes Y, Ozalevli M, Akman H. The comparison of caudal ketamine, alfentanil and ketamine plus alfentanil administration for postoperative analgesia in children. *Paediatr Anaesth*. 2002 Sep;12(7):610-6 | [PubMed](#) |
 200. De Negri P, Ivani G, Visconti C, De Vivo P. How to prolong postoperative analgesia after caudal anaesthesia with ropivacaine in children: S-ketamine versus clonidine. *Paediatr Anaesth*. 2001 Nov;11(6):679-83 | [PubMed](#) |
 201. Pan AK, Rudra A. Caudal Analgesia in Paediatrics: Comparison between Bupivacaine Alone and in Combination with Ketamine, Midazolam and Ketamine-Midazolam. *J Anaesthesiol Clin Pharmacol*. 2005 Oct;21(4): 401
 202. Parkhouse J, Marriott G. Postoperative analgesia with ketamine and pethidine. *Anaesthesia*. 1977 Mar;32(3):285-9 | [PubMed](#) |
 203. Pathania J, Sodhi SS, Thakur JR. Comparison of Efficacy and Duration of Caudal Analgesia Produced by Bupivacaine Alone and in Combination with Adrenaline and Ketamine in Children. *J Anaesthesiol Clin Pharmacol*. 2003 Apr;19(2): 207-211 | [Link](#) |
 204. Tan PH, Kuo MC, Kao PF, Chia YY, Liu K. Patient-controlled epidural analgesia with morphine or morphine plus ketamine for post-operative pain relief. *Eur J Anaesthesiol*. 1999 Dec;16(12):820-5 | [PubMed](#) |
 205. Pirzadeh A, Mohammadi MA, Allaf-Akbari S, Entezariasl M. The effect of ketamine on posttonsillectomy pain in children: a clinical trial. *Iran J Otorhinolaryngol*. 2012 Winter;24(66):23-8 | [PubMed](#) |
 206. Reeves M, Lindholm DE, Myles PS, Fletcher H, Hunt JO. Adding ketamine to morphine for patient-controlled analgesia after major abdominal surgery: a double-blinded, randomized controlled trial. *Anesth Analg*. 2001 Jul;93(1):116-20 | [PubMed](#) |

207. Marcus RJ, Victoria BA, Rushman SC, Thompson JP. Comparison of ketamine and morphine for analgesia after tonsillectomy in children. *Br J Anaesth.* 2000 Jun;84(6):739-42 | [PubMed](#) |
208. Aspinall RL, Mayor A. A prospective randomized controlled study of the efficacy of ketamine for postoperative pain relief in children after adenotonsillectomy. *Paediatr Anaesth.* 2001 May;11(3):333-6 | [PubMed](#) |
209. Safavi M, Honarmand A, Habibabady MR, Baraty S, Aghadavoudi O. Assessing intravenous ketamine and intravenous dexamethasone separately and in combination for early oral intake, vomiting and postoperative pain relief in children following tonsillectomy. *Med Arh.* 2012;66(2):111-5 | [PubMed](#) |
210. Santawat U, Pongraweevan O, Lertakayamanee J, Rushatamukayanunt P, Phalakornkule N, Svasdi-Xuto O. Can ketamine potentiate the analgesic effect of epidural morphine, preincisional or postincisional administration? *J Med Assoc Thai.* 2002 Sep;85 Suppl 3:S1024-30 | [PubMed](#) |
211. Semple D, Findlow D, Aldridge LM, Doyle E. The optimal dose of ketamine for caudal epidural blockade in children. *Anaesthesia.* 1996 Dec;51(12):1170-2 | [PubMed](#) |
212. Sen H, Sizlan A, Yanarates O, Emirkadi H, Ozkan S, Dagli G, et al. A comparison of gabapentin and ketamine in acute and chronic pain after hysterectomy. *Anesth Analg.* 2009 Nov;109(5):1645-50 | [CrossRef](#) | [PubMed](#) |
213. Peat SJ, Bras P, Hanna MH. A double-blind comparison of epidural ketamine and diamorphine for postoperative analgesia. *Anaesthesia.* 1989 Jul;44(7):555-8 | [PubMed](#) |
214. Somasundaran S, Garasia M. A Comparative Study of Ketamine and Tramadol as Additives to Plain Bupivacaine in Caudal Anaesthesia in Children. *Internet Journal of Anesthesiology.* 2008;17(2) | [Link](#) |
215. Spreng UJ, Dahl V, Ræder J. Effects of Perioperative S (+) Ketamine Infusion Added to Multimodal Analgesia in Patients Undergoing Ambulatory Haemorrhoidectomy. *Scand J Pain.* 2010 Apr;1(2): 100-105 | [CrossRef](#) |
216. Subramaniam B, Subramaniam K, Pawar DK, Sennaraj B. Preoperative epidural ketamine in combination with morphine does not have a clinically relevant intra- and postoperative opioid-sparing effect. *Anesth Analg.* 2001 Nov;93(5):1321-6 | [PubMed](#) |
217. Subramaniam K, Subramaniam B, Pawar DK, Kumar L. Evaluation of the safety and efficacy of epidural ketamine combined with morphine for postoperative analgesia after major upper abdominal surgery. *J Clin Anesth.* 2001 Aug;13(5):339-44 | [PubMed](#) |
218. Suzuki M, Haraguti S, Sugimoto K, Kikutani T, Shimada Y, Sakamoto A. Low-dose intravenous ketamine potentiates epidural analgesia after thoracotomy. *Anesthesiology.* 2006 Jul;105(1):111-9 | [PubMed](#) |
219. Svetlic G, Farzanegan F, Zmoos P, Zmoos S, Eichenberger U, Curatolo M. Is the combination of morphine with ketamine better than morphine alone for postoperative intravenous patient-controlled analgesia? *Anesth Analg.* 2008 Jan;106(1):287-93 | [CrossRef](#) | [PubMed](#) |
220. Taheri R, Seyedhejazi M, Ghojazadeh M, Ghabili K, Shayeghi S. Comparison of ketamine and fentanyl for postoperative pain relief in children following adenotonsillectomy. *Pak J Biol Sci.* 2011 May 15;14(10):572-7 | [PubMed](#) |
221. Tanaka M, Sato M, Saito A, Nishikawa T. Reevaluation of rectal ketamine premedication in children: comparison with rectal midazolam. *Anesthesiology.* 2000 Nov;93(5):1217-24 | [PubMed](#) |
222. Tarkkila P, Viitanen H, Mennander S, Annila P. Comparison of remifentanyl versus ketamine for paediatric day case adenoidectomy. *Acta Anaesthesiol Belg.* 2003;54(3):217-22 | [PubMed](#) |
223. Taurá P, Fuster J, Blasi A, Martinez-Ocon J, Anglada T, Beltran J, et al. Postoperative pain relief after hepatic resection in cirrhotic patients: the efficacy of a single small dose of ketamine plus morphine epidurally. *Anesth Analg.* 2003 Feb;96(2):475-80 | [PubMed](#) |
224. Tverskoy M, Oren M, Vaskovich M, Dashkovsky I, Kissin I. Ketamine enhances local anesthetic and analgesic effects of bupivacaine by peripheral mechanism: a study in postoperative patients. *Neurosci Lett.* 1996 Aug 30;215(1):5-8 | [PubMed](#) |
225. Umuroglu T, Eti Z, Ciftçi H, Yilmaz Gögüs F. Analgesia for adenotonsillectomy in children: a comparison of morphine, ketamine and tramadol. *Paediatr Anaesth.* 2004 Jul;14(7):568-73 | [PubMed](#) |
226. Unlügenç H, Gündüz M, Ozalevli M, Akman H. A comparative study on the analgesic effect of tramadol, tramadol plus magnesium, and tramadol plus ketamine for postoperative pain management after major abdominal surgery. *Acta Anaesthesiol Scand.* 2002 Sep;46(8):1025-30 | [PubMed](#) |
227. Unlügenç H, Ozalevli M, Güler T, Isik G. Postoperative pain management with intravenous patient-controlled morphine: comparison of the effect of adding magnesium or ketamine. *Eur J Anaesthesiol.* 2003 May;20(5):416-21 | [PubMed](#) |
228. Tekelioglu UY, Apuhan T, Akkaya A, Demirhan A, Yildiz I, Simsek T, et al. Comparison of topical tramadol and ketamine in pain treatment after tonsillectomy. *Paediatr Anaesth.* 2013 Jun;23(6):496-501 | [CrossRef](#) | [PubMed](#) |
229. Wang Q, Wang Z, Wang B. Continuous Intravenous Infusion of Low Dose of Ketamine Combined with Morphine Used for Postoperative Analgesia in Patients with Cervical Spinal Cord Injury. *Chinese Journal of Rehabilitation Theory and Practice.* 2007;13(1): 86-88 | [Link](#) |
230. Murray WB, Yankelowitz SM, le Roux M, Bester HF. Prevention of post-tonsillectomy pain with analgesic doses of ketamine. *S Afr Med J.* 1987 Dec 19;72(12):839-42 | [PubMed](#) |
231. Weber F, Wulf H. Caudal bupivacaine and s(+)-ketamine for postoperative analgesia in children. *Paediatr Anaesth.* 2003 Mar;13(3):244-8 | [PubMed](#) |
232. Batra YK, Shamsah M, Al-Khasti MJ, Rawdhan HJ, Al-Qattan AR, Belani KG. Intraoperative small-dose ketamine does not reduce pain or analgesic

- consumption during perioperative opioid analgesia in children after tonsillectomy. *Int J Clin Pharmacol Ther.* 2007 Mar;45(3):155-60 | [PubMed](#) |
233. Chia YY, Liu K, Liu YC, Chang HC, Wong CS. Adding ketamine in a multimodal patient-controlled epidural regimen reduces postoperative pain and analgesic consumption. *Anesth Analg.* 1998 Jun;86(6):1245-9 | [PubMed](#) |
234. Siddiqui Q, Chowdhury E. Caudal Analgesia in Paediatrics: A Comparison between Bupivacaine and Ketamine. *Internet J Anesthesiol.* 2006; 11 | [Link](#) |
235. Azevedo VM, Lauretti GR, Pereira NL, Reis MP. Transdermal ketamine as an adjuvant for postoperative analgesia after abdominal gynecological surgery using lidocaine epidural blockade. *Anesth Analg.* 2000 Dec;91(6):1479-82 | [PubMed](#) |
236. Kakinohana M, Hasegawa A, Taira Y, Okuda Y. [Pre-emptive analgesia with intravenous ketamine reduces postoperative pain in young patients after appendectomy: a randomized control study]. *Masui.* 2000 Oct;49(10):1092-6 | [PubMed](#) |
237. Kawana Y, Sato H, Shimada H, Fujita N, Ueda Y, Hayashi A, Araki Y. Epidural ketamine for postoperative pain relief after gynecologic operations: a double-blind study and comparison with epidural morphine. *Anesth Analg.* 1987 Aug;66(8):735-8 | [PubMed](#) |
238. Lauretti GR, Oliveira AP, Rodrigues AM, Paccola CA. The effect of transdermal nitroglycerin on spinal S(+)-ketamine antinociception following orthopedic surgery. *J Clin Anesth.* 2001 Dec;13(8):576-81 | [PubMed](#) |
239. Lee IO, Kim WK, Kong MH, Lee MK, Kim NS, Choi YS, Lim SH. No enhancement of sensory and motor blockade by ketamine added to ropivacaine interscalene brachial plexus blockade. *Acta Anaesthesiol Scand.* 2002 Aug;46(7):821-6 | [PubMed](#) |
240. Qureshi FA, Mellis PT, McFadden MA. Efficacy of oral ketamine for providing sedation and analgesia to children requiring laceration repair. *Pediatr Emerg Care.* 1995 Apr;11(2):93-7 | [PubMed](#) |
241. Rosseland LA, Stubhaug A, Sandberg L, Breivik H. Intra-articular (IA) catheter administration of postoperative analgesics. A new trial design allows evaluation of baseline pain, demonstrates large variation in need of analgesics, and finds no analgesic effect of IA ketamine compared with IA saline. *Pain.* 2003 Jul;104(1-2):25-34 | [PubMed](#) |
242. Weir PS, Fee JP. Double-blind comparison of extradural block with three bupivacaine-ketamine mixtures in knee arthroplasty. *Br J Anaesth.* 1998 Mar;80(3):299-301 | [PubMed](#) |
243. Zohar E, Luban I, Zunser I, Shapiro A, Jedeikin R, Fredman B. Patient-controlled bupivacaine wound instillation following cesarean section: the lack of efficacy of adjuvant ketamine. *J Clin Anesth.* 2002 Nov;14(7):505-11 | [PubMed](#) |
244. Yanli Y, Eren A. The effect of extradural ketamine on onset time and sensory block in extradural anaesthesia with bupivacaine. *Anaesthesia.* 1996 Jan;51(1):84-6 | [PubMed](#) |
245. Wu M, Xing C, Ren Y, Dong L, Liu B, Jiang H. Peri-Operative Low Dose Ketamine to Reduce Postoperative Morphine Consumption. *Journal of the Fourth Military Medical University.* 2004;25(23): 2161 | [Link](#) |
246. American Society of Anesthesiologists Task Force on Acute Pain Management. Practice guidelines for acute pain management in the perioperative setting: an updated report by the American Society of Anesthesiologists Task Force on Acute Pain Management. *Anesthesiology.* 2012 Feb;116(2):248-73 | [CrossRef](#) | [PubMed](#) |
247. Schug SA, Palmer GM, Scott DA, Halliwell R, Trinca J. Acute pain management: scientific evidence, fourth edition, 2015. *Med J Aust.* 2016 May 2;204(8):315-7 | [PubMed](#) |
248. Wang N, Fu Y, Ma H, Wang J. Clinical research regarding preemptive analgesic effect of preoperative ketamine after transurethral resection of prostate. *Middle East J Anaesthesiol.* 2015 Oct;23(3):295-300 | [PubMed](#) |
249. Garg N, Panda NB, Gandhi KA, Bhagat H, Batra YK, Grover VK, et al. Comparison of Small Dose Ketamine and Dexmedetomidine Infusion for Postoperative Analgesia in Spine Surgery--A Prospective Randomized Double-blind Placebo Controlled Study. *J Neurosurg Anesthesiol.* 2016 Jan;28(1):27-31 | [CrossRef](#) | [PubMed](#) |
250. Haliloglu M, Ozdemir M, Uztire N, Cenksoy PO, Bakan N. Perioperative low-dose ketamine improves postoperative analgesia following Cesarean delivery with general anesthesia. *J Matern Fetal Neonatal Med.* 2016 Mar;29(6):962-6 | [CrossRef](#) | [PubMed](#) |

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