The clinical efficacy of three application methods of local anesthesia in percutaneous vertebroplasty: A retrospective single-center cohort study

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Abstract

Background: Although various studies have described the methods of anaesthesia in percutaneous vertebroplasty(PV) in treating osteoporotic vertebral compression fractures (OVCFs), there is still no consensus on the optimal treatment regimen.The study aims to investigate the efficacy of three application methods of local anesthesia in PV treating OVCFs.

Methods: A total of 96 patients of OVCFs were reviewed and divided into three groups(A: lidocaine, B: ropivacaine, C: lidocaine+ropivacaine). The visual analog scale(VAS), blood pressure(BP), heart rate(HR), blood oxygen saturation(BOS), surgery time were recorded at the points of before puncture, puncture, cement injection, and after surgery.

Results: The mean age of the patients was 74.13±7.02 years in group A, 70.47±5.50 years in group B, and 73.07±7.51 years respectively without significant difference. No significant differences were found in the sex, age, hospital stay, surgery time, blood loss, and cement volume. During the period of before surgery and 4-hour after surgery, the VAS in group C decreased significantly at the period of puncture, cement injection, immediately after surgery. Overall, the systolic BP, diastolic BP, HR, BOS during the different period among the groups, there were no significant differences except the HR in the period of the puncture in group C was slower than that in other groups and HR in the period of cement injection in the group A was faster than other two groups. A correlation was observed between the VAS and the period of cement injection(r=0.5358), after surgery(r=0.5775) in group C.

Conclusion: In conclusion, the use of the lidocaine in combination with ropivacaine could relieve the effective intraoperative pain in PV treating OVCFs patients which is reliable and safe.

Background

Osteoporotic vertebral compression fractures(OVCFs) is a common fracture event with gradually higher morbidity and mortality as that increases in the elderly. An estimated 1.4 million of new fractures occurred every year worldwide[1–2]. OVCFs have been treated with conservative managements, such as bed rest, analgesics, braces while surgical treatment are percutaneous vertebroplasty(PV) or percutaneous kyphoplasty (PK) or segmental instrumentation. Besides, PV is usually performed under local anesthesia[3–5], which facilitates the communication and cooperation between the surgeons and patients during the operation, so that the surgeons can obtain the accurate feedback from the patients and ensure the surgery safety. Usually, the surgeons use analgesics to reduce patients intraoperative pain, but the central analgesics could cause respiratory inhibition, nausea, vomiting, urine retention, irritability, and other adverse reactions. And anti-inflammatory painkillers also have adverse reactions such as liver and kidney function dysfunction and of platelet activity inhibition 6–10. In our study, we investigated the clinical importance and efficacy of the three different methods of local anesthetic drugs in PV treating the OVCFs.

Methods

Population selection

This study was approved by the Institutional Review Board of our hospital and conducted according to the principles of the Declaration of Helsinki. All the patients provided their written informed consent to participate and volunteered to be divided into three groups in our study prior to the storage of their data in the hospital database. From January 2019 to June 2019, 96 patients with OVCFs were treated in our department. All surgical procedures were performed by the same senior surgeon. In group A, 33 patients received PV using local anesthesia of the lidocaine, in group B, 31 patients using the local anesthesia of the ropivacaine, in group C, 32 patients using the local anesthesia of the lidocaine in combination with the ropivacaine. The inclusion criteria were: acute fracture of one-level OVCFs, fractures with osteoporosis (T score<-2.5), confirmed by magnetic resonance imaging(MRI). The exclusion criteria were: metastatic fractures or primary tumor or high energy trauma fractures, allergic to local anesthetic drugs no hypertension history.

Surgical methods

The patient was placed in a prone position. PV was performed bilaterally or unilaterally under a C-arm X-rays guidance (Ziehm Imaging Systems) using local anesthesia. In group A, the 2% of the lidocaine was diluted to 1% in group B, the 1% of the ropivacaine was diluted to 0.5%, in the group C, the 1% lidocaine and the 0.5% ropivacaine were mixed for the local anesthesia. The total volume of local anesthetic drugs in each group was 20 milliliters(ml). The injection technique of local anesthetic drugs: the skin injection for a pimple, the subcutaneous tissue injection about 1-2 ml, the deep fascia injection about 5 ml, the intramuscular injection about 1-2 ml, the superior facet joint about 5 ml. A bone needle was percutaneously inserted into the posterior one-third of the fractured vertebral body. The working cannula, was transpedicularly advanced into the vertebral body. Afterward, polymethylmethacrylate (PMMA)was slowly injected into the fractured body. The surgical hemorrhage, surgical time and the cement volume were recorded accordingly.

Outcome indexes

For all the patients, the following data were observed preoperatively, postoperatively, and during the operation: (1) the surgery time, surgical hemorrhage, hospital stay, cement volume, (2)The visual analog scale(VAS), blood pressure(BP), heart rate(HR), blood oxygen saturation(BOS), surgery time and adverse reactions were recorded at points of before puncture, puncture, cement injection and after surgery.

Statistical analysis

All statistical data were analyzed with Statistic Analysis System (SAS Institute Inc., Cary, NC, USA). Quantitative data are presented as means and standard deviations. Repeated measures ANOVA was used for the statistical analysis of differences in mean values and the chi-squared test was used for

categorical data. The correlation analysis was performed for multiple comparisons. Statistical significance was defined as a p-value <0.05.

Results

The mean age of 96 patients was 74.13 ± 7.02 years in group A, 70.47 ± 5.50 years in group B, and 73.07 ± 7.51 years respectively without significant difference (P > 0.05). No significant differences were found in the sex, age, hospital stay, surgery time, blood loss, and cement volume(Table 1).

Among the groups, as the surgery time prolongs, the VAS declines gradually. During the period before surgery and 4-hour after surgery, the VAS was found no significant difference except the period of puncture, cement injection, immediately after surgery which the VAS in group C decreased significantly(Table 2). Overall, the systolic BP, diastolic BP, HR, BOS during the different period among the groups, there were no significant differences except the HR in the period of the puncture in group C was slower than that in group A and B, and HR in the period of cement injection in the group A was faster than other two groups(Table 3).

In the group C, a correlation was observed between the VAS and the period of cement injection(r = 0.5358, p = 0.0395), after surgery(r = 0.5775, p = 0.0242). However, there was no correlation with surgery time in group A or in group B(Fig. 1).

Table 1
Characteristics and clinical findings

Index	Group A	Group B	Group C	P_{AB}	P_{AC}	P_{BC}
Male/Female(n)	11/22	10/21	12/20	0.0805	0.3126	0.4929
Mean age (years)	74.13 ± 7.02	70.47 ± 5.50	73.07 ± 7.51	0.3085	0.3466	0.6418
Hospital stay (days)	6.80 ± 1.47	6.86 ± 1.68	6.60 ± 1.24	0.9801	0.8601	0.9236
Surgery time (minutes)	39.67 ± 13.26	37.53 ± 9.71	40.73 ± 10.75	0.9423	0.9210	0.8650
Blood loss (ml)	7.00 ± 2.54	6.33 ± 2.29	7.33 ± 3.20	0.5314	0.7570	0.3966
Cement volume(ml)	5.02 ± 0.73	4.70 ± 0.98	4.50 ± 0.84	0.7524	0.5360	0.7551

Table 2
The VAS during the different period

Index	Group A	Group B	Group C	P_{AB}	P_{AC}	P_{BC}
Before surgery	4.80 ± 0.68	4.93 ± 1.10	5.00 ± 0.85	0.9729	0.7953	0.7338
Puncture	5.13 ± 0.52*	4.53 ± 0.74*	4.33 ± 0.49*	0.2546	0.0965	0.7438
Cement injection	4.73 ± 0.79*	4.13 ± 0.99*	3.33 ± 1.48*	0.3253	0.1963	0.6415
Immediate after surgery	2.60 ± 0.51*	2.46 ± 0.57*	1.53 ± 0.52*	0.4219	0.0347	0.0459
4-hour after surgery	1.66 ± 0.49*	1.46 ± 0.52*	0.93 ± 0.48*	0.4429	0.0002	0.0003
*$p < 0.05$ VAS vs before the surgery						

Table 3
The systolic BP, diastolic BP, HR, BOS during the different periods

Index	Group A	Group B	Group C	P_{AB}	P_{AC}	P_{BC}
Before surgery						
Systolic BP	152.1 ± 13.24	148.3 ± 10.91	149.1 ± 9.67	0.4985	0.4843	0.7891
Diastolic BP	81.0 ± 5.32	85.53 ± 4.85	82.67 ± 4.67	0.4018	0.2879	0.4366
HR	96.47 ± 6.53	92.60 ± 7.53	93.20 ± 8.57	0.0591	0.0527	0.4699
BOS	98.33 ± 0.89	98.13 ± 0.92	98.33 ± 0.81	0.8454	0.8835	0.8024
Puncture						
Systolic BP	148.7 ± 10.12	148.30 ± 10.91	141.30 ± 6.17	0.2714	0.0523	0.0617
Diastolic BP	86.87 ± 5.49	85.53 ± 4.85	84.53 ± 3.56	0.4250	0.3705	0.4209
HR	93.80 ± 4.25	92.60 ± 4.53	87.67 ± 2.60	0.9725	0.0014	0.0008
BOS	98.40 ± 0.63	98.13 ± 0.92	98.93 ± 1.03	0.8824	0.8039	0.8061
Cement injection						
Systolic BP	141.7 ± 10.34	139.20 ± 8.28	142.70 ± 10.22	0.4219	0.2879	0.270
Diastolic BP	87.87 ± 5.34	81.73 ± 5.51	83.20 ± 5.27	0.0022	0.0082	0.6346
HR	90.00 ± 5.03	86.80 ± 3.44	85.47 ± 4.64	0.0001	0.0010	0.5190
BOS	98.33 ± 0.72	98.07 ± 0.96	98.73 ± 0.88	0.8929	0.8706	0.8789
After surgery						
Systolic BP	137.60 ± 7.57	140.00 ± 7.94	134.90 ± 6.84	0.4119	0.0750	0.250
Diastolic BP	79.73 ± 3.56	78.53 ± 3.64	78.20 ± 3.47	0.6040	0.5089	0.8563
HR	79.60 ± 3.81	79.60 ± 3.81	79.60 ± 3.84	0.9078	0.9182	0.9249
BOS	98.73 ± 0.79	98.87 ± 0.74	98.33 ± 0.72	0.8488	0.8979	0.8718

Discussion

OVCFs are considered as stable injuries and the patients are treated conservatively with bed rest, analgesics, brace, early rehabilitation, and osteoporosis treatments, they tend to progressively collapse, resulting in chronic pain, progressive kyphosis, or even delayed paralysis1–5. Surgical managements such as PV or PK are widely preferred for the vertebral height restoration, the kyphosis correction and pain relief. However, the OVCFs patients often suffer many comorbidities and the general anesthesia is a great risk for them[6, 9–10]. The PV is usually performed under local anesthesia, which facilitates the

communication and cooperation between the surgeons and patients during the surgery so that the surgeons can obtain timely and accurate feedback from the patients and ensure the surgery safety of the operation[11–14]. At present, there is still a consensus on how to reduce or even eliminate the pain during PV[11–17]. Currently, in the PV, the lidocaine as a routine local anesthetic works fast but doesn't last too long. Hence, the patients always suffered or even the local anesthesia was transformed to the general anesthesia. Therefore, finding a suitable method for relieve the pain is the key to the PV. The ropivacaine works in about 15 minutes and could last 3–5 hours. In our study, group B and group C obtained the affirmative effect of local anesthesia and the VAS decreased significantly. In addition, at different periods, especially in the group C, at the period of puncture, cement injection, immediately after surgery which the VAS decreased significantly and a correlation was observed between the VAS and the period of cement injection and after surgery, which could make sure the patients cooperation in the surgery and which could also maintain enough anesthesia time for the surgeon, ensuring the patients' safety.

Furthermore, the systolic BP, diastolic BP, HR, BOS during the different period among the groups except the HR in the period of the puncture in group C was slower than that in group A and B, and HR in the period of cement injection in the group A was faster than other two groups, there were no significant differences. We noticed that the application combination of lidocaine and ropivacaine has an overall regulatory effect, intraoperative circulation, stable breathing, small physiological disturbances, short postoperative recovery time. Hence, the combination of short-acting local anesthetic and long-acting local anesthetic could satisfy the surgery, reduce surgical complications,and improve the quality of surgery which could provide a new way in the PV treatment of OVCFs.

Conclusion

The use of the lidocaine in combination with ropivacaine could relieve the effective intraoperative pain in PV treating OVCFs which is reliable and safe. The present study, for the first time, investigated the three application methods of local anaesthetics in PV. However, our study has a few limitations. First, the retrospective nature of the study indicates the possibly of bias. Second, because the two local anaesthetic drugs were limited because there are more managements for relieving the pain during the surgery, such as the analgesics, the opioids drugs, the sedatives. Third, PK patients with OVCFs were not included, and only one-level OVCFs were discussed. In the future, prospective, randomized, grouped studies with long-term follow-up periods are needed.

Declarations

Acknowledgements

Not applicable.

Consent for publication

Not Applicable.

Authors' contributions

Contributions: (I) conception and design: WYZ, XJiL; (II) administrative support: XJieL and TJH; (III) provision of study materials or patients: WYZ, XJiL,TJH; (IV) collection and assembly of data: WYZ and XJieL; (V) data analysis and interpretation: WYZ and XJiL. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to the data is confidential patient data but are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The Institutional Review Board of the First Affiliated Hospital of Chongqing Medical University approved this study.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

OVCFs: osteoporotic vertebral compression fractures; PV: percutaneous vertebroplasty; VAS: visual analogue scale; VAS: The visual analog scale; BP: blood pressure; HR: heart rate; BOS: blood oxygen saturation; PK: percutaneous kyphoplasty; PMMA: polymethylmethacrylate; BMD: bone mineral density; MRI: magnetic resonance imaging

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Figures

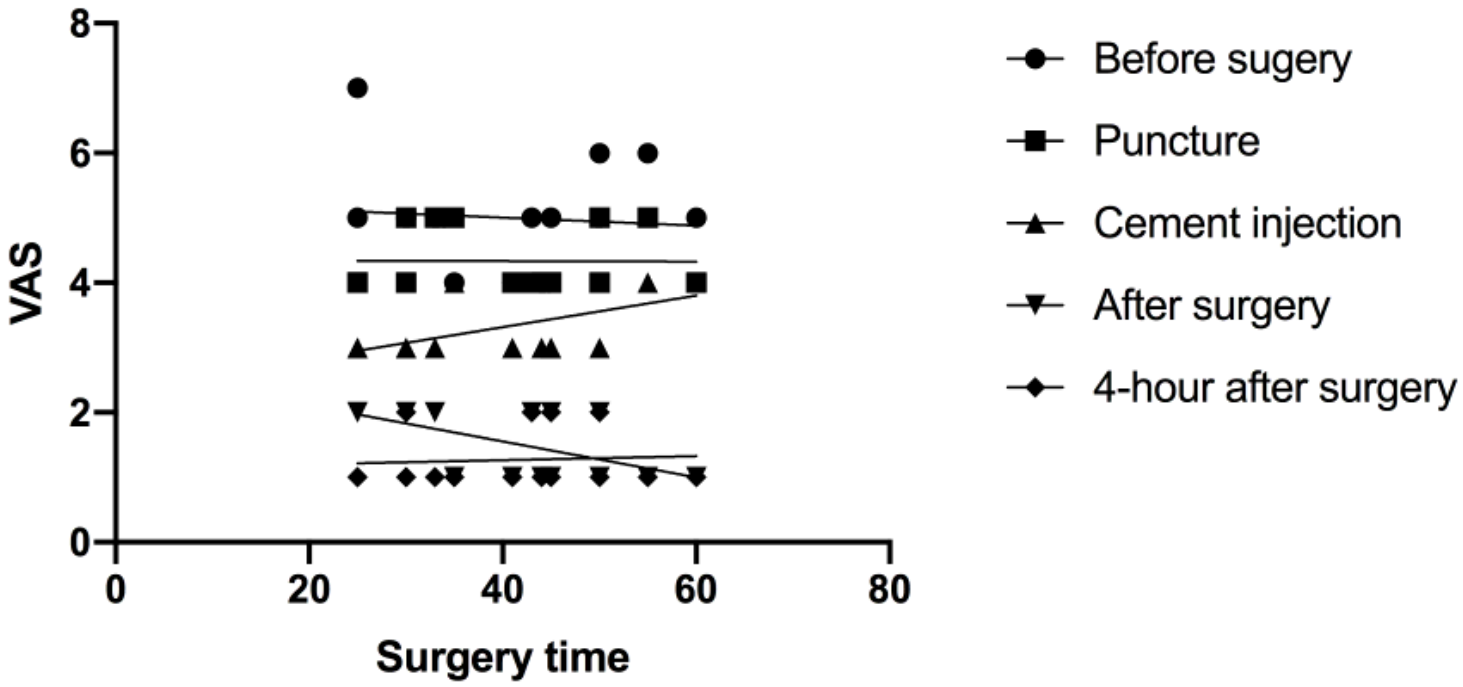

Figure 1

The correlation of the VAS and the surgery time