International Journal of Spine Surgery, Vol. 12, No. 5, 2018, pp. 543–548
https://doi.org/10.14444/5066

The Effect of Kyphoplasty on Mortality in Symptomatic Vertebral Compression Fractures: A Review

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ABSTRACT

Background: Vertebral compression fractures (VCFs) are common comorbidities encountered in the elderly, and they are on the rise. Kyphoplasty may be superior in VCF management compared with conservative management. A comprehensive review of literature was conducted, focusing on the effect of kyphoplasty on mortality and overall survivorship in patients with a diagnosis of symptomatic VCFs.

Methods: A comprehensive literature search was conducted to find recently published literature on kyphoplasty effects on mortality using the following keywords: "kyphoplasty," "mortality," "morbidity," "vertebral compression fractures," and "survivorship." We only included articles that listed one of their primary or secondary outcomes as morbidity and mortality after a kyphoplasty procedure in VCF patients.

Results: Of 27 articles, only 6 articles met the inclusion criteria. Studies have reported that surgical procedures have decreased the mortality rate in symptomatic VCF patients. Four studies concluded that the mortality rate was lower after kyphoplasty compared with vertebroplasty and nonoperative treatments. One study reported there was no significant difference between kyphoplasty and nonoperative management. One study summarized that the mortality rate was not significantly different between kyphoplasty and vertebroplasty.

Conclusions: Multicenter prospective and randomized control studies are required to fully evaluate the decreasing trend of mortality rates after a kyphoplasty procedure.

Other & Special Categories

Keywords: kyphoplasty, mortality, morbidity, vertebral compression fractures, survivorship

INTRODUCTION

Vertebral compression fractures (VCFs) are one of the most common comorbidities encountered in the elderly population, and the incidence is increasing as the percentage of the aging population rises. The annual incidence of VCFs is 750 000 in the United States.[1,2] The associated mortality rate in these patients is 2.5 times higher compared with patients without VCFs.[3] Nonoperative treatment, kyphoplasty, and vertebroplasty are available options for the management of symptomatic compressive vertebral fractures. Bed rest and analgesics for the management of VCFs are known to further accelerate bone loss and muscle wasting. Immobility can also result in systemic complications (pulmonary, cardiovascular, musculoskeletal, or immune) and are often responsible for decreasing survival rates in VCF patients.

Minimally invasive percutaneous techniques, such as vertebroplasty and kyphoplasty, have evolved. Several kyphoplasty and vertebroplasty studies have been published in the English-language literature. Most of these studies have concentrated on clinical outcomes, such as pain, disability, quality of life, and complications associated with the procedures in immediate, short-term, and long-term follow-ups. These studies have reported that minimally invasive techniques are effective in treating symptomatic VCF patients.

Kyphoplasty relies on the use of a balloon to create a cavity in the vertebral body which is then filled with methyl methacrylate.[4] Kyphoplasty has been found to be effective in reducing postoperative pain, and improving the quality of life and mobility in patients with painful VCFs. The clinical outcomes have been reported as sustained for up to 2 years of follow-up. Likewise, kyphoplasty, as assessed radiographically, has been shown to improve and maintain the vertebral height and kyphotic angle out to 2 years of follow-up. In addition, kyphoplasty has shown early improve-

Table. Summary of published articles about the effect of kyphoplasty on mortality rates in vertebral compression fractures patients.

Source, y	Study Design	n	Comparisons	Conclusion
Lavelle et al,[5] 2008	Retrospective	184	Conservative; kyphoplasty	Mortality rate was not significantly different between kyphoplasty and conservative cohorts.
Edidin et al,[6] 2011	Retrospective	858 978	Nonoperative; kyphoplasty; vertebroplasty	The 4-year survival rates were 62.8% for kyphoplasty and 57.3% for vertebroplasty. Operated patients were 37% less likely to die compared with nonoperated patients at 4-year follow-up.
Chen et al,[7] 2013	Retrospective	72 693	Nonoperative; kyphoplasty; vertebroplasty	The 3-year survival rates were 59.9%, 49.7%, and 42.3% for kyphoplasty, vertebroplasty, and nonoperated cohorts, respectively.
Edidin et al,[8] 2013	Retrospective	858 978	Nonoperative; kyphoplasty; vertebroplasty	Adjusted life expectancy was 85% higher in operated patients compared with nonoperated patients. Kyphoplasty patients had 115% and 34% greater adjusted life expectancy compared with nonoperated and vertebroplasty groups, respectively.
Lange et al,[10] 2015	Retrospective	3605	Nonoperative; kyphoplasty; vertebroplasty	At 5-year follow-up, the operated patients were 43% less likely to die compared with the nonoperated patients. Mortality rate was not significantly different between kyphoplasty and vertebroplasty.
Edidin et al,[9] 2015	Retrospective	1 038 956	Nonoperative; kyphoplasty; vertebroplasty	The 4-year adjusted mortality risk was 74% higher in the nonoperated cohort compared with kyphoplasty, and 17% lower in kyphoplasty compared with vertebroplasty.

ment in pain and disability scores, with a reduced use of analgesic medications in both osteoporotic and tumor-related painful VCF patients. The complication rate of kyphoplasty is low postoperatively, and there is no difference in complication rates between kyphoplasty and vertebroplasty. Furthermore, there is no difference in new fracture rates and adjacent fracture rates between the 2 methods. Asymptomatic cement extravasations are common; however, cement embolism, although rare in occurrence, has been reported. Overall, kyphoplasty appears superior in the management of painful VCFs compared with conservative management.

Many studies have investigated the safety and efficacy of kyphoplasty; however, only a few studies have been conducted to determine the effect of kyphoplasty on survivorship. The objective of this study was to perform a comprehensive review of literature focusing on the effect of kyphoplasty on mortality and overall survivorship in patients diagnosed with symptomatic VCFs.

METHODS

A comprehensive literature search was conducted to find recently published literature on kyphoplasty effects on mortality outcomes. A thorough Medline and PubMed search was completed with search criteria that included the words "kyphoplasty," "mortality," "morbidity," "vertebral compression fractures," and "survivorship." After a detailed search, only 27 articles were found in the literature. We included articles from 2006 to the present and studies published in the English language. We only included articles that listed one of their primary or secondary outcomes as morbidity and mortality after a kyphoplasty procedure in VCF patients. Articles were included only if they were both retrospective or prospective studies, and case reports were excluded from the review. This limited this review to 6 articles (Table).

Kyphoplasty

Indications

Kyphoplasty is generally recommended in the treatment of osteoporotic or osteolytic painful progressive VCFs. Kyphoplasty has been shown to provide symptomatic relief in patients with VCFs from primary spinal tumors or metastatic spine tumors. Kyphoplasty is typically useful in patients who are bedridden and unable to mobilize because of the pain associated with VCFs. Early pain relief and mobility are crucial in avoiding complications associated with prolonged recumbency, like pneumonia, deep vein thrombosis, pulmonary embolism, or decubiti.

Contraindication

Kyphoplasty is usually contraindicated in patients who have posterior wall disruption as a result of extension of the fracture or by infiltrative process in the case of metastatic lesions.

Kyphoplasty Effect on Morbidity and Mortality

In 2008, Lavelle et al[5] retrospectively reviewed patients with osteoporotic VCFs to evaluate mortality rates in conservatively managed patients versus patients managed by kyphoplasty. Treatment

selection was determined based on the patient's discussion with the orthopedic spine surgeon. Conservative treatment consisted of oral analgesia and bracing. A total of 94 patients chose to undergo kyphoplasty, whereas 90 patients chose to undergo conservative treatment in the form of bracing and analgesia. Lavelle et al[5] studied the number of patients who died in both groups by the end of the study duration. They reported no significant difference in mortality rates between the kyphoplasty group (age-adjusted mortality rate of 40.1 per 1000 patient-years) and the conservative treatment group (35.3 per 1000 patient-years). The authors noticed that the patients who had undergone kyphoplasty (mean age, 76.9 years) were older in age and had higher Charlson scores than the conservative treatment group (mean age, 68.6 years). They assumed older age and higher medical comorbidities could be a reason for the higher mortality rate with a kyphoplasty.

In 2011, Edidin et al[6] evaluated the mortality risk in a total of 858 978 VCF patients who were managed with kyphoplasty, vertebroplasty, and nonoperative treatments in the 100% US Medicare data (both inpatient and outpatient). The study evaluated the relative risk of mortality for VCFs treated with nonoperative and operative treatment modalities. A total of 13.9% of the patients underwent kyphoplasty, 7.4% of patients underwent vertebroplasty, and the remaining 78.7% of patients underwent conservative treatment. Patients in the operative cohort were found to have a higher adjusted survival rate of 60.8% at the end of the fourth year compared with the nonoperative cohort (50%; $P < .001$). Vertebroplasty and kyphoplasty patients were 37% less likely to die compared with patients treated nonoperatively. The relative risk of mortality in kyphoplasty patients was 23% lower than that for vertebroplasty. The 4-year survival rates were 62.8% for kyphoplasty and 57.3% for vertebroplasty. After adjusting for covariates, the analysis showed that among the patients who survived their first year following diagnosis of a VCF, the adjusted mortality risk was 18% lower in the operated group than in the nonoperated group by the end of the study. The study noticed the mortality risk was higher in men, patients with high Charlson Comorbidity Index scores, and patients with chronic obstructive pulmonary disease, cancer, hip fracture, other heart disease, pneumonia, and pulmonary heart disease following VCFs, regardless of treatment type. The mortality risk was shown to increase with age regardless of treatment type. The study, however, did not investigate the etiology behind increased mortality in patients from the nonoperative group.

In 2013, Chen et al[7] published survival and morbidity rates in 72 693 VCF patients from the Medicare database who had been managed by nonoperative treatment, vertebroplasty, and kyphoplasty. The study reported high survival rates in the kyphoplasty group at 1 and 3 years (85.2% and 59.9%, respectively), and even in patients stratified by age, compared with nonoperative (73.1% and 42.3%, respectively) and vertebroplasty (78.8% and 49.7%, respectively) groups. The adjusted risk of death was 20% lower in the kyphoplasty group than in the vertebroplasty group. Patients treated nonoperatively were more likely to die during the index hospitalization than patients treated operatively. The in-hospital mortality rate was 0.35% for kyphoplasty versus vertebroplasty (0.53%) and nonoperative treatment (1.72%). Readmission rates, postoperative pulmonary infections, and bedsores at 6 months after discharge were significantly lower in the kyphoplasty group. The duration of hospital stay was significantly lower for kyphoplasty. The subsequent vertebral augmentation procedures were high in kyphoplasty compared with vertebroplasty and nonoperative procedures. This study suggested that the increase in survival rates might be due to early hospital discharge and mobility, and lower postoperative pulmonary-related complications.

In 2013 Edidin et al[8] analyzed life expectancy in VCF patients from the 100% US Medicare data set (2005–2008) and compared kyphoplasty, vertebroplasty and nonoperated patients. A total of 858 978 VCF patients were identified; 119 253 patients had a kyphoplasty (13.9%), and 63 693 patients had a vertebroplasty (7.4%). In the study, specific comorbidities (possible cause of death in VCF patients) 12 months prior to the index VCF event were identified and compared among the nonoperated, operated (both vertebroplasty and kyphoplasty), kyphoplasty, and vertebroplasty cohorts. The distribution of Charlson Comorbidity Index scores was relatively similar among the cohorts. Hip fractures and pneumonia rates were higher, and arterial disease, chronic obstructive pulmonary disease, cancer, hypertension, ischemic heart disease, and pulmonary heart disease were lower in the operated cohort

compared with the nonoperated cohort. Adjusted life expectancy was 85% higher in operated patients compared with nonoperated patients. Across all sex-age groups, the median life expectancy was 2.2–7.3 years greater for operated groups compared with the nonoperated group. Kyphoplasty patients had 115% and 34% greater adjusted life expectancy compared with the nonoperated and vertebroplasty groups, respectively. The women in the kyphoplasty cohort were ages 65 to 69 years, and they had 5.2 years' increase in predicted life expectancy compared with vertebroplasty female patients. This study concluded that VCF patients who had a vertebroplasty experienced less of a survival benefit than those who underwent a kyphoplasty procedure.

In 2015, Edidin et al[9] conducted a study to investigate the mortality and morbidity risk for VCF patients (n = 1 038 956) who were managed by balloon kyphoplasty (BKP), vertebroplasty, and nonoperatively in the US Medicare population. The study reported that the matched cohorts' adjusted 4-year mortality risk was 19% lower in the BKP cohort than in the vertebroplasty cohort, and 55% higher in the nonoperative cohort than in the BKP cohort. In the osteoporotic VCFs subgroup, the adjusted 4-year mortality risk was 70% higher in the nonoperative cohort than in the BKP group, and 17% lower in the BKP group than in the vertebroplasty cohort. The adjusted risks of pneumonia, deep vein thrombosis, and urinary tract infections were higher; and subsequent augmentation/fusion and augmentation, and pulmonary/respiratory complications were lower in the nonoperative cohort than in the BKP cohort, respectively, at the 4-year follow-up.

In 2015, Lange et al[10] conducted a study in patients (German claims data) with osteoporotic VCFs (n = 3605). A total of 598 patients (16.6%) underwent operative intervention, whereas the remaining 3009 patients (83.4%) were treated nonoperatively. The operated group consisted of relatively younger patients compared with the patients treated conservatively. At 5 years, the unadjusted survival rate for the operated cohort (65.6%) was significantly higher ($P < .001$) compared with the nonoperated group (51.9%). The operated group patients were 43% less likely to die compared with the nonoperated patients at the conclusion of the study. The group did not find any statistical difference in the survival rate between patients treated with BKP versus vertebroplasty. The total costs for kyphoplasty were lower versus vertebroplasty because of less medication use.

DISCUSSION

Osteoporotic VCFs are common in the elderly and have a higher incidence in women. Studies have shown that the mortality rate is higher in patients with VCFs than those without.[11–15] The causes for death in patients with VCFs are multifactorial. Associated comorbidities, number of vertebral fractures, age, sex, treatment, and socioeconomic status are risk factors influencing the survival rates. The causes of death in VCF patients are mostly from associated comorbidities and rarely from the fracture itself. Kado et al[12] reported in a prospective study that the high proportion of deaths in VCF patients were from pulmonary diseases or cancers. Another study from a Swedish patients' registry found only 28% of deaths in osteoporotic VCFs were from the fracture itself.[16] Age is another factor affecting the mortality rates in VCF patients. Mortality rates have been reported to be higher in older VCF patients than in younger VCF patients. Lavelle et al[5] reported that the mortality rate was significantly higher in older patients versus younger patients irrespective of their treatment plan. Edidin et al[6] found mortality risk tended to increase with age. The increasing number of VCFs is associated with decreasing survival rates.[17] The mortality risk is found to be greater in men than women.[14,18] Patients from a lower socioeconomic status are often linked to higher morbidity and mortality, because of their higher likelihood of malnutrition, obesity, and smoking.[6]

The influence of surgical procedures on mortality rates in osteoporotic VCF patients compared with conservative measures is still controversial.[19,20] Nevertheless, studies have reported that surgical procedures have decreased the vertebral fracture–associated mortality rates in osteoporotic patients compared with conservative treatments.[3] These surgical procedures have shown improvements in postoperative pain, decreased the use of postoperative opioids and NSAIDs, and allowed for increased mobility, thereby possibly preventing the negative sequelae of immobility. Although both kyphoplasty and vertebroplasty equally have reduced postoperative pain, improved physical disabilities, and postoperative complications, kyphoplasty has the advantage of better restoration

of the kyphotic angle. There is a disagreement in terms of vertebral height restoration, because some studies have claimed kyphoplasty is better at restoring the vertebral body height and others have reported that there is no difference between the procedures.[21,22] However, fracture kyphosis can compromise pulmonary function.[23] The restoration of the kyphotic angle might aid in the improvement of pulmonary function and could be one of the reasons for higher survival rates in patients who have undergone a kyphoplasty procedure.[6,10,24] Chen et al[7] found that kyphoplasty patients during the 6-month follow-up were least likely to have been hospitalized for pneumonia and bed sores, and they suggested this might be due to better improvement in pulmonary function and mobility, which might increase the survival rates.

The research on the effect of kyphoplasty on mortality outcomes is very limited, with only a few articles being published in the English-language literature, and most of these studies are retrospective cohorts. These studies have not looked into the etiologies behind deaths in these patients. The indications for kyphoplasty have been variable in different studies. In the study by Lange et al,[10] the operated group consisted of relatively younger patients compared with the nonoperative group, whereas Lavelle et al[5] found the operative group comprised relatively older patients with more comorbidities. The difference in cohort characteristics signifies differences in indications for operative procedures. Multicenter prospective and randomized control studies are required to fully evaluate the decreasing trend of mortality rates after a kyphoplasty procedure. Future studies also need to look into the effect of recurrent fractures or multilevel compression fractures on the survivorship of the patient. Likewise, further research is needed to evaluate the effect of kyphoplasty on survival rates for cancer-associated VCFs.

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Disclosures and COI: There were no sources of funding from any source for this study. There were no grants for this paper, and no authors have any personal or institutional financial interest in drugs, materials, or devices described in this submission.

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Published 15 October 2018