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Anterior reconstruction versus posterior osteotomy in treating Kümmell's disease with neurological deficits: A systematic review

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ABSTRACT

Objective: This study aimed to conduct a systematic review of literature comparing the clinical effectiveness and safety between anterior reconstruction (AR) and posterior osteotomy (PO) in the treatment of Kümmell's disease with neurological deficits.

Methods: We systematically reviewed the literature in PubMed, EMBASE, Cochrane Database of Systematic Reviews, and the Web of Science for "spin*," "surg*," "Kümmell's disease," "Kummell's disease," "Kummell disease," "vertebral osteonecrosis," "vertebral pseudarthrosis," "intravertebral vacuum cleft," "delayed vertebral collapse," and "compression fracture nonunion". Quality was assessed using the Grading of Recommendations, Assessment, Development, and Evaluation method.

Results: A total of 10 publications involving 268 Kümmell's disease patients with neurological deficits were included in this review, with 7 studies of low- or very low-quality. There were 37.7% and 62.3% of patients receiving AR and PO, respectively. For clinical outcomes, AR group showed no significant differences in pain, neurological dysfunction, and imaging outcome improvements compared with patients who underwent PO. However, the incidence of implant-related complications including loose screw, screw fracture, screw disconnection, and plate dislodgment, was higher in AR group compared with PO group (21.6% vs. 14.3%). As another major complication, AR group more often required a second surgery.

Conclusion: This systematic review demonstrated that both AR and PO could improve pain, neurological dysfunction and imaging outcomes. However, serious comorbidities, multilevel corpectomies and/or severe osteoporosis highly required PO. Design discrepancies were found in the current studies, further higher-quality studies are warranted.

Level of evidence: Level III, therapeutic study.

Introduction

Kümmell's disease, first described by Dr Hermann Kümmell in 1891, is defined as avascular osteonecrosis and occurs after delayed posttraumatic vertebral collapse, mostly in an osteoporotic spine.[1–3] Currently, percutaneous vertebroplasty (PVP) and kyphoplasty (PKP) achieve pain relief and satisfactory deformity correction in Kümmell's disease without neurologic deficits.[4,5] However, in patients with neurological deficits, cement augmentation is inappropriate.[6,7] Due to complicated neurologic compromise, those cases have to receive open surgery for spinal cord decompression and spine stabilization.

Anterior reconstruction (AR) and posterior osteotomy (PO) have been proposed for the management of Kümmell's disease with neurological deficits. AR could resect the retropulsed bony

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Table 1
General results.

Study, year	Study type	Operation	Patients	Age (years)	Hospitalized time (Days)	Operation time (min)	Blood loss (ml)	Follow-up (Months)
Wang et al[11] 2015	Cohort	AR	13	68.4 (57–79)	5 (3–12)	81.6 ± 21.5	185 ± 52	24.3 (6–37)
		PO	17	69.6 (56–79)	4 (3–10)	65.4 ± 17.6	178 ± 47	23.2 (8–32)
Kashii et al[12] 2013	Cohort	AR	27	73.6 ± 6.9	NR	360 (360 ± 81)	950 (1420 ± 1464)	NR
		PO	36	74.6 ± 65.9	NR	348 (387 ± 113)	1207 (1377 ± 1054)	NR
Uchida et al[13] 2010	Cohort	AR	30	71.4 ± 5.3	NR	NR	NR	4.5 ± 1.9 Years
		PO	25	69.3 ± 7.5	NR	NR	NR	4.7 ± 2.1 Years
Zhang et al[14] 2015	Case series	PO	12	64 (55–75)	NR	148 (100–220)	625 (450–850)	33 (26–43)
Patil et al[6] 2013	Case series	PO	10	67.3 (48–85)	NR	NR	NR	25.4 (12–38)
Kanayama et al[17] 2010	Case series	AR	31	70.8 (57–87)	NR	193 (150–285)	436 (100–1350)	30.8
Long et al[18] 2009	Case series	PO	16	64.6 ± 3.5	NR	197 ± 39	766 ± 46	29 (12–54)
Saita et al[16] 2008	Case series	PO	13	75.2 (63–83)	NR	279 (220–340)	917 (390–1850)g	36.4 (6–71)
Li et al[9] 2007	Case series	PO	24	72 ± 8	4.5 ± 2.2 (3–10)	70.4 ± 17.2 (45–90)	150 ± 72 (100–450)	48 (30–76)
Kim et al[15] 2003	Case series	PO	14	67 (62–72)	NR	217 (150–300)	682 (420–1210)	36 (24–54)

fragments directly and provide anterior column support.[8] Meanwhile, PO is currently a common treatment with the advantages of dissecting the retropulsed posterior cortex by posterior spinal shortening osteotomy and correction of kyphotic deformity.[9] However, these major surgical interventions are challenging because of patients' advanced age, numerous comorbid medical complications, and frequent instrumentation failure secondary to severe osteoporosis.[10] With regard to the advantages and disadvantages of AR and PO, it remains unclear which of these procedures is optimal. In addition, to date, an absence of systematic literature reviews on comparing these two surgical procedures in the treatment of Kümmell's disease with neurological deficits provides the impetus for this systematic review.

We therefore performed a systematic review of the literature to comprehensively evaluate the evidence for the clinical and imaging outcomes as well as complications of AR and PO, respectively, for Kümmell's disease with neurological deficits, comparing these two surgical procedures.

Methods

The two clinically relevant questions below were determined by consensus among a panel of spine experts, and a systematic review of related literature was conducted. Specific clinical questions were as follows:

1 In patients with Kümmell's disease and neurological deficits, what is the impact of different surgical approaches (AR versus PO) on pain relief and functional outcomes?
2 In patients with Kümmell's disease and neurological deficits, what is the impact of different surgical approaches (AR versus PO) on complications?

Search terms including “spin*”, “surg*”, “Kümmell's disease”, “Kummell's disease”, “Kummell disease”, “vertebral osteonecrosis”, “vertebral pseudarthrosis”, “intravertebral vacuum cleft”, “delayed vertebral collapse”, and “compression fracture nonunion” were used to search literature from PubMed, EMBASE, Cochrane Database of Systematic Reviews, and the Web of Science. We screened the references of the obtained articles for any additional studies. The inclusion criteria were: Kümmell's disease with neurological deficits; detailed description of the neurological status; detailed description of AR or PO procedure; length of the follow-up period; report of any peri/postoperative complications associated with surgery; statistical analysis of postoperative outcomes. NonEnglish articles, technical notes, letters to the editors, abstracts only, conference presentations, commentaries, case reports, and narrative and quantitative reviews were excluded. Due to the limited evidence available on the topic, case series were included in this study.

Initial database searches retrieved 1876 studies. The respective abstracts were independently reviewed by 3 investigators (F.L., Z.C., and C.L.), and all relevant articles were read in full. Stringent exclusion criteria were applied, finally, 10 articles[6,9,11–18] were considered eligible for the study, including 3 articles reporting results from cohort study, and 7 articles reporting results from case series (Table 1). Among the 10 articles, 4 assessed AR, while 9 evaluated PO.

The quality of evidence for each article was evaluated as high, moderate, low, or very low. The systematic review results and evidence quality rating were assessed by a group of multidisciplinary scientist, spine experts and methodologists. The group then went through a consensus-based decision making process using a modified Delphi technique to arrive at treatment recommendations related to the key clinical questions. This process and the strength of the recommendations were based on the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) method. All included articles were evaluated independently by the authors according to the GRADE criteria.[19]

Results

AR versus PO

Only 3 cohort trials[11–13] compared AR and PO for clinical and radiological data. These studies all found no significant differences between the two procedures with respect to pain relief, neurological and function improvement (Table 2). They found that postoperative kyphotic angle in both groups was significantly reduced in a comparison with the preoperative. Kashii et al[12] reported that AR showed a higher loss of correction rate at follow-up than PO but didn't reach a significant difference. Meanwhile, Uchida et al[13] reported an opposite result that PO showed a significant higher loss of correction rate than AR (Table 3). Kashii et al[12] also reported no significant differences between the two operations in the estimated mean blood loss and mean duration of surgery. However, Wang et al[11] reported overtly longer operation time and slightly increased blood loss in AR compared with PO (Table 1).

AR: effectiveness and safety

One retrospective case series study[17] and 3 cohort studies were identified about the effectiveness and safety of AR. The data from the above studies could not be pooled because of missing data and

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