

# Halo-pelvic traction for severe kyphotic deformity secondary to spinal tuberculosis

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## Abstract

To evaluate the efficacy and safety of Halo-pelvic ring traction in the treatment of severe kyphotic deformity secondary to spinal tuberculosis.

Eighty patients with severe kyphotic deformity due to spinal tuberculosis were included in the study. Forty of those patients (experimental group) received Halo-pelvic ring traction before surgery and the rest (control group) received surgical treatment directly. Two groups were compared by means of the duration of surgery, intraoperative blood loss, correction of Cobb angle, change in patient height, and American Spinal Injury Association (ASIA) impairment scale.

Halo-pelvic traction group achieved significantly ( $P < .05$ ) better results than direct surgical treatment group by means of the time of surgery ( $244 \pm 58$  minutes vs  $276 \pm 47$  minutes,  $P = .036$ ), intraoperative blood loss ( $950 \pm 236$  mL vs  $1150 \pm 305$  mL,  $P = .018$ ), correction of Cobb angle ( $68.3 \pm 12.6$  vs  $55.6 \pm 13.8$ ,  $P = .001$ ), change in patient height ( $9.4 \pm 4.0$  cm vs  $6.8 \pm 3.8$  cm,  $P = .024$ ). The mean improvement of ASIA scale was more in the experimental group than in the control group ( $0.23 \pm 0.07$  vs  $0.15 \pm 0.06$ ); however, the difference is not statistically significant ( $P = .09$ ).

Halo-pelvic ring traction before osteotomy can be applied in patients with severe spinal kyphotic deformity due to spinal tuberculosis to increase efficacy and safety of surgical treatment.

**Abbreviations:** ANOVA = one-way analysis of variance, ASIA = American Spinal Injury Association, HIV = human immunodeficiency virus.

**Keywords:** halo-pelvic ring, kyphosis, osteotomy, spinal tuberculosis

## 1. Introduction

Due to the development of drug-resistant bacteria types and spreading of human immunodeficiency virus (HIV) virus, prevalence of tuberculosis is resurging in developing countries. There are estimated 20 million patients with tuberculosis, and 8 to 10 million patients are newly increased each year.<sup>[1]</sup> 1.4 million people died from tuberculosis in just the year of 2011.<sup>[2]</sup> Bone is one of the most common sites of tuberculosis outside lung. And almost half of those infections are in the vertebral body. Severe spinal deformity is often the outcome in spinal tuberculosis patients who failed to receive timely and adequate treatment. In

the treatment of patients with severe kyphotic deformity, adverse surgical treatment is always necessary. However, the procedure of vertebrectomy can be time consuming and liable to cause complications such as spinal cord injury and large amount of intraoperative hemorrhage.

In our center, we have used halo-pelvic traction on a series of patients with severe kyphotic deformity before carrying out vertebrectomy, and the results were mostly satisfactory. To find if this method is better than direct osteotomy without halo-pelvic traction, we have retrospectively reviewed the patients who received this treatment and those who only received surgical treatment during the same period of time.

## 2. Methods

### 2.1. Patient inclusion

All the procedures were approved by the ethics committee of the Sixth Affiliated Hospital of Xinjiang Medical University. The clinical materials of 80 patients (48 males, 32 females, average age: 33, range 16–52) were retrospectively included in the study. Among those patients, 40 patients (26 males, 32 females, average age: 33, range 16–52) in the experimental group were treated with 8 to 10 week halo-pelvic traction before the surgery, and the rest (22 males, 18 females, average age: 33, range 16–52) of the patients (control group) underwent surgical treatment without halo-pelvic traction.

### 2.2. Instrumentation

The halo-pelvic traction apparatus was designed by one of our senior surgeons (YM). It is consisted of a halo ring, a pelvic ring,

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The study was approved by the ethical committee of The Sixth Affiliated Hospital of Xinjiang Medical University.

AM and YM have contributed equally for this work.

The authors have no conflicts of interest to disclose.

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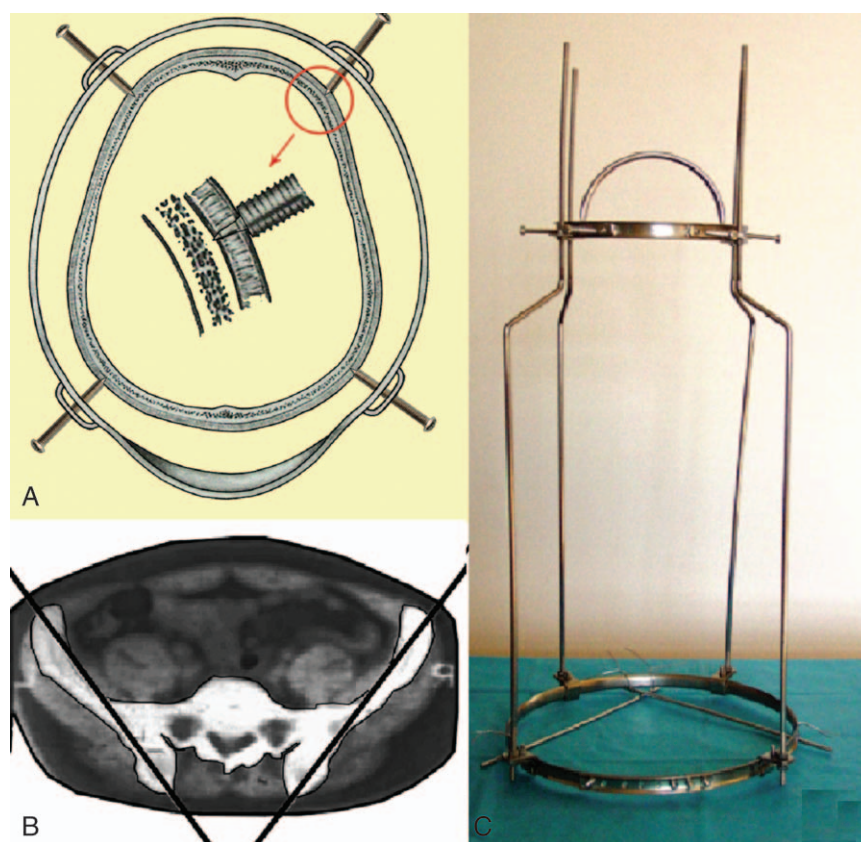
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**Figure 1.** Pins in the cranial bone were placed with the same method as a halo ring (A). Two pins on the pelvic ring were inserted in the iliac crest and 2 in the posterior superior iliac spine (B). The correcting rods were used to connect the halo and pelvic rings, and were adjusted 3 to 5 mm a day to distract the spine between the 2 rings (C).

pins to fix them in the cranial and iliac bone and correcting rods to align the two rings and distract the spine (Fig. 1).

### 2.3. Methods of treatment

Traction and surgical correction of the kyphotic deformity was scheduled on patients when the infection is completely under control. The halo-pelvic traction was performed on patients 8 to 10 weeks before. The halo-pelvic ring was placed under regional anesthesia. Pins in the cranial bone were placed with the same method as a halo ring. Two pins on the pelvic ring were inserted in the iliac crest and 2 in the posterior superior iliac spine. The correcting rods were used to connect the halo and pelvic rings, and were adjusted 3 to 5 mm a day to distract the spine between the 2 rings (Fig. 2).

Osteotomy and correction of spinal deformity was carried out with the patient in supine position. Blood transfusion was applied when necessary. Eight hundred to 1200 mL of blood was transfused in most cases. Functional assessment of the spinal cord was carried out by wake-up test and evoked potential monitoring.

Time for the surgery, volume of intraoperative blood loss, correction of Cobb angle, change in patient height, and American Spinal Injury Association (ASIA) impairment scale before and after the treatment were compared between the 2 groups.

### 2.4. Statistical analysis

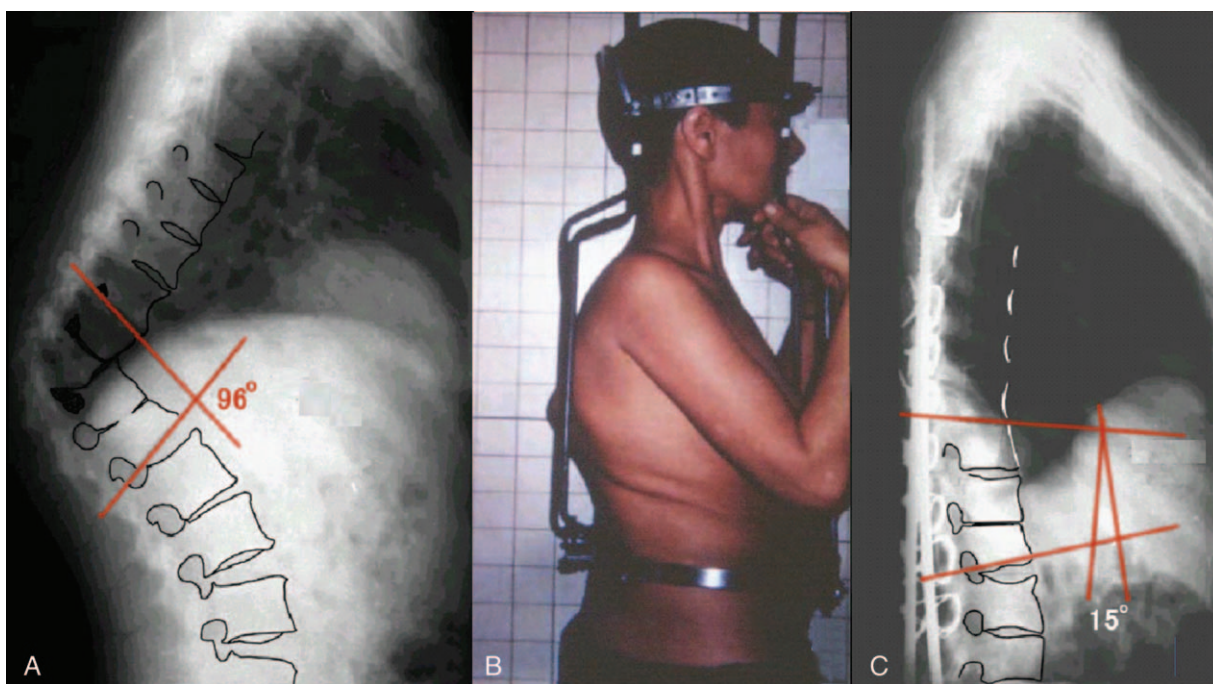
Statistical analysis was performed using the SPSS 22.0 software. Descriptive statistics of measurement data included mean,

standard deviation. *t* test was performed for between-group comparisons, while one-way analysis of variance (ANOVA) was used for within-group comparisons. The difference was considered significant when  $P < .05$ .

### 3. Results

After the treatment, the average correction ratio of deformity was 70.35% in experimental group and 60% in control group. Significant differences ( $P < .05$ ) were found among the 2 groups concerning intraoperative time and blood loss, correction of Cobb angle and change in patient height (Table 1).

After the surgery, all the patients were advised to pay follow-up visits in our spine clinic once in every 3 months for the first year, and twice each year afterward. The patients included in the current study paid follow-up visits for 2 to 19 years. During the follow-up, bone at the osteotomy site fused satisfactorily in all the patients. According to the ASIA impairment scale, 2 patients in the control group suffered from surgery-related spinal cord injury, and the ASIA score was dropped from E to C postoperatively, but both returned to D at the last follow-up. Before the traction and surgical treatment, there were 5, 16, 19 patients in the experimental group and 6, 17, 17 in the control group with grades C, D, and E injury assessed by ASIA Impairment Scale of spinal cord injury<sup>[3]</sup>; 2 years after the surgery, there were 2, 13, 25 patients in the experimental group and 2, 18, 20 in the control group with grades C, D, and E (Table 2). The mean increase in ASIA scale was more in the experimental group than in the control group ( $0.23 \pm 0.07$  vs



**Figure 2.** Patient 1: 30-year-old female, found a bump on her back 5 years ago, along with symptoms such as back pain, low fever, and sweat. X ray showed tuberculosis of T11, T12 levels with the Cobb angle of 96° (A). No paraspinous abscess was found, erythrocyte sedimentation rate was normal and the bone around the deficit was of fine quality. After 33 days of halo-pelvic fixation (B), the patient received spinal osteotomy under regional anesthesia. After the surgery, the Cobb angle was 15° (C).

0.15 ± 0.06); however, the difference is not statistically significant ( $P = .09$ ). It is likely that patients who received halo-pelvic traction before surgery tend to achieve better functional recovery after spinal cord injury.

#### 4. Discussion

Spine is one of the most common sites of tuberculosis invasion outside of lung. Such invasions can result in the collapse of vertebral body, injury of the spinal cord, and even paraplegia in some severe cases.<sup>[4]</sup> Failure to treat the spinal tuberculosis could result in severe deformity of the spine, impairment of spinal cord, and failure of respiratory function.<sup>[5,6]</sup> Although it was once acceptable for patients to live with kyphotic deformity, now most patients hope to achieve close to normal spinal posture with the least invasive treatment method possible.<sup>[7]</sup>

Before the invention of Harrington technique, best treatment of spinal deformity was external traction. Although this technique may be able to slow down or even reverse the development of

spine deformity, the process was often long and painful and cannot be carried out persistently by many patients. Since the invention of Harrington technique, and the development of other modified internal fixation techniques, now most spinal deformities can be treated by osteotomy and internal fixation. Internal fixation along with decompression and fusion can alleviate the kyphotic deformity, preserve or even promote the recovery of respiratory and neural functions.<sup>[8]</sup> However, treatment of severe kyphotic deformities requires complex osteotomy by highly skilled surgeons, and always accompanies with various complications such as dural tears, spinal cord injuries, peripheral nerve root injuries and vascular injuries, pneumothorax as well as instrumentation failure.<sup>[9-12]</sup> Since the correction of severe spinal deformity requires long segmental instrumentation and correction with strong forces, the time needed for such surgeries is always long and the intraoperative hemorrhage is large. This could be a challenge to both the surgeon and the patient.

The Halo-pelvic ring traction had been applied in the presurgical treatment of various spinal deformities since the 1970s, and some authors reported satisfactory results from those applications.<sup>[13,14]</sup> However, there are few reports on halo-pelvic ring since the beginning of the 21st century. It is possibly because

**Table 1**  
Treatment results of patients with or without halo-pelvic ring.

	Experimental	Control	P	
Time of surgery	244 ± 58	276 ± 47	.036	
Intraoperative blood loss	950 ± 236	1150 ± 305	.018	
Cobb angle	Preoperatively	95.6 ± 22.6	93.7 ± 25.5	.712
	Postoperatively	28.3 ± 13.3	37.4 ± 15.6	.025
change	68.3 ± 12.6	55.6 ± 13.8	.001	
Patient height	Preoperatively	138.5 ± 15.4	137.5 ± 13.6	.641
	Postoperatively	147.3 ± 16.8	144.7 ± 13.3	.153
change	9.4 ± 4.0	6.8 ± 3.8	.024	

**Table 2**  
ASIA scale assessment before the treatment and at the last follow-up.

	Before treatment			At the last follow-up		
	C	D	E	C	D	E
Experimental	5	16	19	2	13	25
Control	6	17	17	2	18	20

ASIA = American Spinal Injury Association.



of the reluctance of patients to receive long periods of external fixation due to its inconvenience and unflattering appearance.<sup>[15]</sup>

While China is one of the countries with the highest prevalence of tuberculosis in the world, Xinjiang is one of the regions with the highest prevalence of tuberculosis in China. Due to economic reasons, many patients with spinal tuberculosis do not seek medical attention until the spine deformity is severe enough to affect their respiratory function. The average Cobb angle of patients in the current study was 94.9°, and most of those patients already had trouble in breathing when they were presented to our clinic.

A type of self-designed halo-pelvic ring has been used in our center since the eight decade of last century, and it had been applied in many patients with satisfactory results. Especially for patients with severe spinal deformities and low income, halo-pelvic traction was an effective and affordable means of conservative treatment.

Halo-pelvic ring can help with treatment of severe kyphotic deformity of the spine by at least 2 mechanisms. First, by traction it can significantly reduce kyphotic deformity of the spine to an extent that can be achieved by a surgical intervention. The traction procedure gives the surgeon a general idea on the extent of correction of spinal deformity, and makes the intraoperative instrumentation easier due to the already adjusted paraspinal structures. In our case series, the time of the surgery and intraoperative hemorrhage were significantly lower in the experimental group than in the control group. Moreover, with the relatively long period of traction, spinal cord and its blood vessels were adjusted to the increased length of the spinal canal and this could avoid the functional damage due to spinal cord injury. In the current study, our case series, the time of the surgery, intraoperative hemorrhage were significantly lower than was reported in the treatment of severe kyphotic deformity by other authors.

## 5. Conclusion

Halo-pelvic traction is an effective and affordable apparatus in the preoperative conservative treatment of patients with severe

spinal deformity secondary to spinal tuberculosis, and can be considered by spine surgeons in clinical practice.

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