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## Retrospective Study

## Application of a modified surgical position in anterior approach for total cervical artificial disc replacement

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## Abstract

## BACKGROUND

Total cervical artificial disc replacement (TDR) has been considered a safe and effective alternative surgical treatment for cervical spondylosis and degenerative disc disease that have failed to improve with conservative methods. Positioning the surgical patient is a critical part of the procedure. Appropriate patient positioning is crucial not only for the safety of the patient but also for optimizing surgical exposure, ensuring adequate and safe anesthesia, and allowing the surgeon to operate comfortably during lengthy procedures. The surgical posture is the traditional position used in anterior cervical approach; in general, patients are in a supine position with a pad under their shoulders and a ring-shaped pillow under their head.

## AIM

To investigate the clinical outcomes of the use of a modified surgical position versus the traditional surgical position in anterior approach for TDR.

## METHODS

In the modified position group, the patients had a soft pillow under their neck, and their jaw and both shoulders were fixed with wide tape. The analyzed data included intraoperative blood loss, position setting time, total operation time, and perioperative blood pressure and heart rate.

## RESULTS

Blood pressure and heart rate were not significantly different before and after body positioning in both groups ( $P > 0.05$ ). Compared with the traditional position group, the modified position group showed a statistically significantly



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longer position setting time ( $P < 0.05$ ). However, the total operation time and intraoperative blood loss were significantly reduced in the modified position group compared with the traditional position group ( $P < 0.05$ ).

## CONCLUSION

The clinical outcomes indicated that total operation time and intraoperative blood loss were relatively lower in the modified position group than in the traditional position group, thus reducing the risks of surgery while increasing the position setting time. The modified surgical position is a safe and effective method to be used in anterior approach for TDR surgery.

**Key words:** Anterior approach; Surgical position; Total cervical artificial disc replacement; Cervical spondylosis

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**Core tip:** This article was designed to investigate the clinical outcomes of the use of a modified surgical position versus the traditional surgical position in anterior approach for total cervical artificial disc replacement (TDR). The clinical outcomes indicated that total operation time and intraoperative blood loss were relatively lower in the modified position group than in the traditional position group, thus reducing the risks of surgery while increasing the position setting time. The modified surgical position is a safe and effective method to be used in anterior approach for TDR surgery.

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## INTRODUCTION

Artificial cervical disc prosthesis was designed by utilizing bionics technology, thus preserving the activity of the treated segment, and its design was first reported by Goffin *et al*<sup>[1]</sup> in 2002. Total cervical artificial disc replacement (TDR) has been considered a safe and effective alternative surgical treatment for cervical spondylosis and degenerative disc disease that have failed to improve with conservative methods<sup>[2-9]</sup>.

Positioning the surgical patient is a critical part of the procedure. Appropriate patient positioning is crucial not only for the safety of the patient but also for optimizing surgical exposure, ensuring adequate and safe anesthesia, and allowing the surgeon to operate comfortably during lengthy procedures<sup>[10,11]</sup>.

The surgical posture is the traditional position used in anterior cervical approach; in general, patients are in a supine position with a pad under their shoulders and a ring-shaped pillow under their head<sup>[12,13]</sup>. The activity of the adjacent segment accelerates the degeneration of the adjacent layers and causes new symptoms<sup>[8,14-17]</sup>.

To enable an improved TDR procedure, shorten the time of operation, reduce the incidence of perioperative complications, and improve the safety of the procedure, we planned to improve the traditional surgical position in anterior cervical approach.

In this study, a total of 48 cervical spondylosis patients who were treated by TDR with either the traditional or the modified surgical position were assessed. We comprehensively determined the clinical outcomes, including the blood pressure and heart rate before and after body positioning, position setting time, total operation time, and intraoperative blood loss.

## MATERIALS AND METHODS

### Patients

All patients were initially assessed and treated by trained nurses before being enrolled in this study. Patients received a diagnosis of cervical spondylosis of one

segmental level that was supported by clinical symptoms and imaging data and had poor clinical outcomes even after previously undergoing strict conservative treatment for at least three months.

### **Study design and parameters**

Forty-eight patients were divided into a traditional position group and a modified position group, with 24 patients in each group (Table 1). Perioperative parameters were retrospectively analyzed.

To assess the safety of the position setting process, blood pressure and heart rate were used, and these metrics were measured in all patients before and after the position setting process in both groups. In addition, the surgical position setting time was measured. After surgery, total operation time and intraoperative blood loss were recorded to evaluate the effects of surgical position on the safety of surgery.

### **Surgical position setting**

**Traditional position group:** The traditional surgical position setting is shown in Figure 1A and B. After anesthesia intubation, the patient's head, neck, and shoulders were lifted, a shoulder pad was placed under the shoulders, and a ring-shaped pillow was placed under the head. Subsequently, the patient was positioned back on the table, and the height and position of the head, neck, and shoulder were checked until the neck was fully exposed.

**Modified position group:** The modified surgical position setting is shown in Figure 1C and D. After anesthesia intubation, a shoulder pad and a ring-shaped pillow were placed under the shoulder and head, respectively. Then, a soft pillow with a height of approximately 10 cm was placed under the patient's neck. The lower jaw was pulled in the rostral direction, both shoulders were pulled in the caudal direction, and tape was used to maintain the position.

### **Statistical analysis**

Data are presented as the mean  $\pm$  SD. Statistical analyses were performed by the independent-samples *t*-test between two groups using SPSS (version 22.0, Chicago, IL), and categorical variables were analyzed by the Mann-Whitney *U* test. Differences of  $P < 0.05$  were considered significant.

## **RESULTS**

### **General patient information**

All patients who underwent single-level Mobi-C artificial disc replacement from September 2014 to September 2015 were included (28 males and 20 females). The average age was 45.7 years (range, 25-65 years). Of the patients, 8 had C3-C4 replacement, 22 had C4-C5 replacement, and 18 had C5-C6 replacement.

There was no significant difference in sex, age, history, treated segment, anesthesia, or surgical staff between the two groups ( $P > 0.05$ ).

### **Blood pressure and heart rate before and after body positioning**

In the traditional position group, the blood pressure was  $124.76 \pm 15.3$  mmHg before body positioning and  $126.69 \pm 18.7$  mmHg after body positioning (Figure 2A). The average heart rate was  $76.36 \pm 14.2$  bpm and  $78.01 \pm 13.8$  bpm in the traditional position group before and after body posture, respectively (Figure 2B).

In the modified position group, the blood pressure before body positioning was  $128.43 \pm 18.8$  mmHg, and it was  $129.33 \pm 17.1$  mmHg after body positioning (Figure 2A). The average heart rate was shown to be  $82.61 \pm 15.0$  bpm and  $83.25 \pm 14.4$  bpm in the modified position group before and after body posture, respectively (Figure 2B).

Blood pressure and heart rate before and after body positioning were not significantly different within each group or between the two groups ( $P > 0.05$ ).

### **Surgical position setting time and total operation time**

The surgical position setting time was  $1.85 \pm 0.49$  min in the traditional position group, and it was  $4.57 \pm 0.67$  min in the modified position group (Figure 3). A statistically significant increase was observed in the modified position group compared with the traditional position group ( $P < 0.05$ ).

The total operation time was significantly shorter in the modified position group ( $82.05 \pm 12.4$  min) than in the traditional position group ( $95.78 \pm 14.5$  min) ( $P < 0.05$ ) (Figure 3).

### **Intraoperative blood loss**



**Table 1** Demographic characteristics of the patients

	Modified group (n = 24)	Traditional group (n = 24)	P value
Male/Female	16/8	12/12	0.439
Age (yr)	46.7 (26-65)	43.3 (25-61)	0.998
Level of surgery			0.551
C3/4	5	3	
C4/5	11	11	
C5/6	8	10	

The intraoperative blood loss in the modified position group ( $20 \pm 8.1$  mL) was significantly lower than that in the traditional position group ( $27 \pm 7.5$  mL;  $P < 0.05$ ) (Figure 4).

## DISCUSSION

Artificial cervical disc prosthesis was designed to reconstruct or maintain the height of the intervertebral disc, maintain the regular activity of the cervical spine, and create favorable conditions for the recovery of function of the spinal cord after the spinal cord compression was removed<sup>[4,18-20]</sup>.

An appropriate surgical position is crucial for the operation. Improvement in the patient's surgical status facilitates the surgeon's procedure and reduces the amount of bleeding and the incidence of complications, thus creating essential conditions for successful implementation of the disc and recovery of the patient<sup>[10,11]</sup>.

In this study, 48 cases of cervical disc replacement with Mobi-C prosthesis were included. Compared with patients in the traditional surgical position, patients in the modified surgical position had more satisfactory clinical outcomes, and the advantages are as follows.

To facilitate the operation and select the appropriate type of prosthesis in TDR, the patient is typically placed in the supine-neutral surgical position to maintain the natural curve of the cervical spine<sup>[8,21-27]</sup>. Because only the shoulder pad and ring-shaped pillow were placed under the shoulders and head, respectively, the neck of the patient was not supported in the traditional surgical position during anterior cervical approach. However, in the modified position, the shoulder pad and ring-shaped pillow were placed under the shoulders and head, respectively, and a soft pillow with a height of approximately 10 cm was placed under the patient's neck so that the patient was in the supine-neutral surgical position during the surgery.

### ***Patients with the modified surgical position are fixed firmly and securely***

During a cervical surgical procedure, slight activity of the patient can have serious consequences, including cervical displacement and injuries of the blood vessels and the spinal cord<sup>[15,23,28-32]</sup>. In the modified position, the lower jaw and both shoulders were pulled in the rostral and the caudal directions, respectively, and wide tape was used for auxiliary fixation. Thus, the cervical spine and other parts of the patient were securely fixed, allowing a successful surgery and guaranteeing the safety of the patients.

### ***Reduced total operative time and intraoperative blood loss***

The total operation time was significantly shorter in the modified position group than in the traditional position group. Intraoperative blood loss in the modified position group was significantly lower than that in the traditional position group.

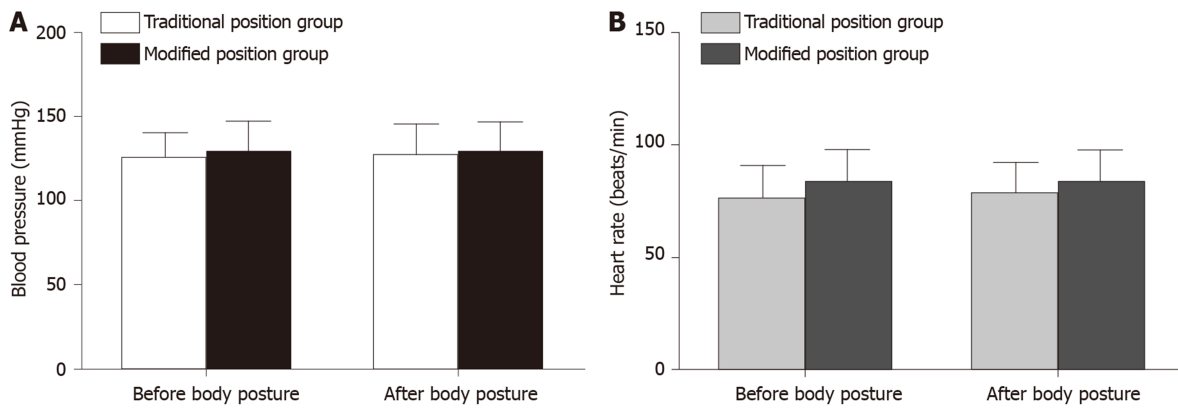
The modified surgical position needs more surgical position setting time. However, the total operation time was shortened, and intraoperative blood loss was reduced in patients with the modified surgical position compared with patients with the traditional position. A shorter operation time results in a lower operation risk, and a smaller amount of bleeding during the operation can not only help the surgeon's activity but also reduce the risk of injury in patients, which is beneficial to the healing process.

In this study, the modified surgical position in anterior approach was successfully designed for TDR. The results indicated that the modified surgical position had no adverse effects on the blood pressure and heart rate of the patient. The modified surgical position reduces the total operation time and intraoperative blood loss, although it consumes more surgical position setting time; these results suggest that

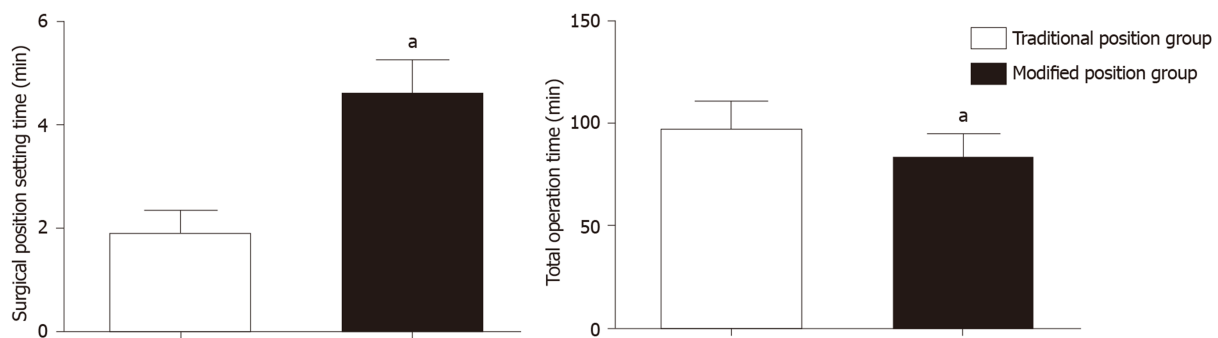


**Figure 1 Surgical position setting.** The traditional position (A and B) and the modified position (C and D) are shown.

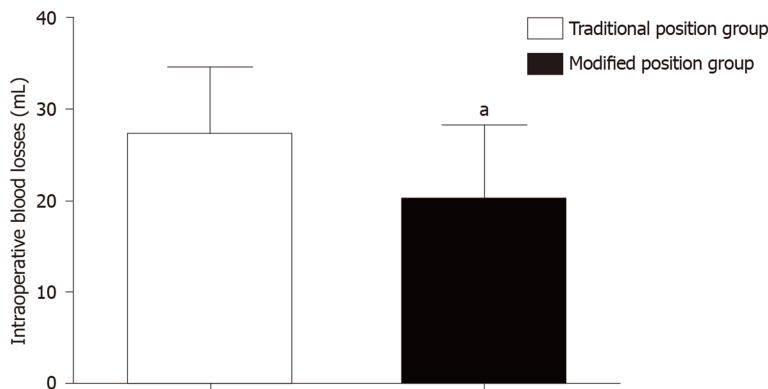
the modified position is beneficial to the operation of the surgeons, and it is worthy of application and widespread use in TDR.



**Figure 2** Patients' blood pressure and heart rate before and after body positioning. A: Blood pressure before and after body positioning; B: Heart rate before and after body positioning. Each value is the mean  $\pm$  SD.



**Figure 3** Position setting time and total operation time in the two groups. Each value is the mean  $\pm$  SD. <sup>a</sup> $P < 0.05$ , statistical significance was considered according to the independent-samples *t*-test.



**Figure 4** Intraoperative blood losses in the two groups. Intraoperative blood loss. Each value is the mean  $\pm$  SD. <sup>a</sup> $P < 0.05$ , statistical significance was considered according to the independent-samples *t*-test.

## ARTICLE HIGHLIGHTS

### Research background

Total cervical artificial disc replacement (TDR) has been considered a safe and effective alternative surgical treatment for cervical spondylosis and degenerative disc disease that have failed to improve with conservative methods.

### Research motivation

Positioning the surgical patient is a critical part of the procedure. Appropriate patient positioning is crucial not only for the safety of the patient but also for optimizing surgical exposure, ensuring adequate and safe anesthesia, and allowing the surgeon to operate comfortably during lengthy procedures. The surgical posture is the traditional position used in

anterior cervical approach; in general, patients are in a supine position with a pad under their shoulders and a ring-shaped pillow under their head. The activity of the adjacent segment accelerates the degeneration of the adjacent layers and causes new symptoms.

### Research objectives

To investigate the clinical outcomes of the use of a modified surgical position versus the traditional surgical position in anterior approach for TDR.

### Research methods

In the modified position group, patients had a soft pillow under their neck, and their jaw and both shoulders were fixed with wide tape. The analyzed data included intraoperative blood loss, position setting time, total operation time, and perioperative blood pressure and heart rate.

### Research results

Blood pressure and heart rate were not significantly different before and after body positioning in both groups. Compared with the traditional position group, the modified position group showed a statistically significantly longer position setting time. However, the total operation time and intraoperative blood loss were significantly reduced in the modified position group compared with the traditional position group.

### Research conclusions

The clinical outcomes indicated that total operation time and intraoperative blood loss were lower in the modified position group than in the traditional position group, thus reducing the risks of surgery while increasing the position setting time.

### Research perspectives

The modified surgical position is a safe and effective method to be used in anterior approach for TDR surgery.

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