The Efficacy of Local Built Khon Kaen Mobile Traction Unit (KK-MTU) to Assist Decompression, Reduction and Fixation in a Spondylolisthesis Operation

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Objective: *To identify the usefulness of using a locally built Khon Kaen Mobile Traction Unit (KK-MTU) to assist clarification of anatomy of the spines, decompression of cauda equina and spinal nerve roots, posterior relocation of the diseased spines, application of pedicular screws and fixation of the spines in anterior spondylolisthesis surgery.*

Material and Method: *Fifty patients with spondylolisthesis had surgery from orthopedic surgeons that used the KK-MTU in a clinical trials phase to assist the operation at the Department of Orthopedics Surgery, Khon Kaen Hospital, between January 6, 2006 and February 11, 2008.*

Results: *Outcomes of spondylolisthesis surgery in 50 patients with the application of this equipment suggests that the operation time and blood loss can be reduced because of the reduction of abdominal pressure. The surgeons also stated that the unit helped to clarify the anatomy of the spines. Moreover, it can ease complications that might arise during the operation due to its facilitated decompression, fixation, and application of other instruments during the surgeries.*

Conclusion: *Newly locally built KK-MTU could facilitate orthopedic surgeries by clarifying the anatomy, reducing, decompressing, and having tools fixed for spondylolisthesis surgery.*

Keywords: *Khon Kaen Mobile Traction Unit (KK-MTU), Spondylolisthesis surgery, Continuous traction, Spine reduction, Decompression, Fixation*

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In patients who have been diagnosed with spondylolisthesis, various surgical techniques have been developed to correspond with the patient's age and surgical experience[1-3]. In patients with spondylolisthesis who are neurologically compromised, surgical reduction is usually done by pulling the pedicular screw to be seated in rods combined with distraction of inter body space with lever instruments to reduce kyphosis[4,5]. This technique may be successful in low grade listhesis or non-rigid listhesis. However, it frequently fails because the screws are being pulled out with stiff listhesis or if it is an osteoporosis patient[4,5].

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During surgery, the patients must be placed in prone position to reduce venous pressure in the abdomen and ensuring that it is free from compression. However, this might cause the diseased spine drift to drop further anteriorly, especially when decompression of the diseased area is done by removing scar tissue and poorly functioning facet joints. The progression of listhesis can worsen the neurological complications[6,7] and cause an ill-defined entry point of the pedicular screws.

As mentioned above, reduction in spondylolitheis surgery has been considered as one of the challenging operations. To deal with possible hurdles in the operation field, the Khon Kaen Mobile Tracking Unit (KK-MTU) has been invented to ease the reduction in this type of surgery. The present study aimed to identify the potential benefit of using the unit.

Material and Method

Study design

The present study is a clinical trial without control (phase I) to identify the potential efficacy of the newly built Khon Kaen Mobile Traction Unit (KK-MTU) in spondylolisthesis surgery.

Study site

The present study was conducted in the Department of Orthopedic Surgery, Khon Kaen Hospital from January 6, 2006 to December 5, 2007.

Participants

Fourteen orthopedic surgeons in the Department of Orthopedic Surgeons, Khon Kaen Hospital who did the spondylolisthesis surgery in 50 consecutive patients during the stated study were asked to identify the efficacy of the KK-MTU. For those 50 patients with the diagnosis of spondylolisthesis, the participants must be aged 18 or over, without underlying disease that contraindicated the operation such as severe cardiovascular disease and chronic ulcer of the back.

Instrument (KK-MTU)

A saline post, with its base mounted to a concrete box attached to four swiveling wheels, to make it more portable, is used (Fig. 1). One metallic pipe 1.2 meters long is welded on top of the saline post. At each end of the pipe, two fixed pulleys are welded tightly. The margin of the pulleys that protrude out of the end of the pipe is small enough to make sure that the rope will not scratch the metal end.

Application of the KK-MTU

After the skin incision and level are identified, assisting reduction is performed by applying one or two (usually two) Kocher clamps pinching the spinous process just above the listhesis level, or in case of degenerative type, pinching the spinous process at the listhesis level and above. Kocher clamps are slipknot tied with a sterile rope. The rope is passed over the two pulleys and hung with an 8-15 kilograms sand bag (Fig. 2). One checked string is loosely tied between the sand bag and the hanging hook of the saline post. This is for safety if Kocher slips out. It is used in case where very heavy traction force is applied.

This device makes continuous traction to the above spinous process(es) in the mild cephalad and opposite direction of deformities, then makes decompression combined with conventional reduction and fixation (Fig. 3, 4 shows reduction by KK-MTU after interbody space clearing and facets removed).

Fig. 1 Khon Kaen Mobile Traction Unit (KK-MTU)

Fig. 2 Application of KK-MTU with 12 kg traction in spondylolisthesis surgery

Outcome measures

Fourteen orthopedic surgeons in the Department of Orthopedic Surgeons, Khon Kaen Hospital who did the spondylolisthesis surgery in 50 selected

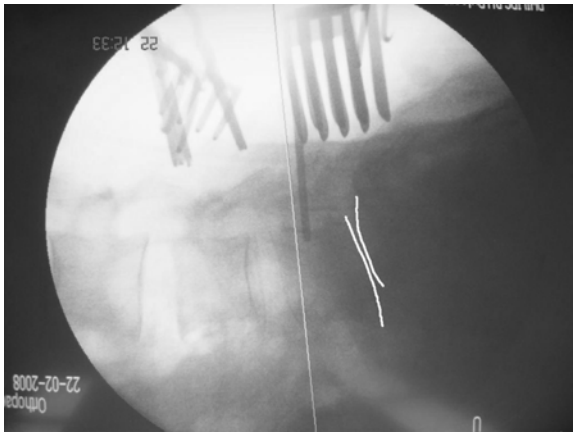

Fig. 3 X-ray film shows spondylolisthesis of L5-S1 removing sand bag from KK-MTU

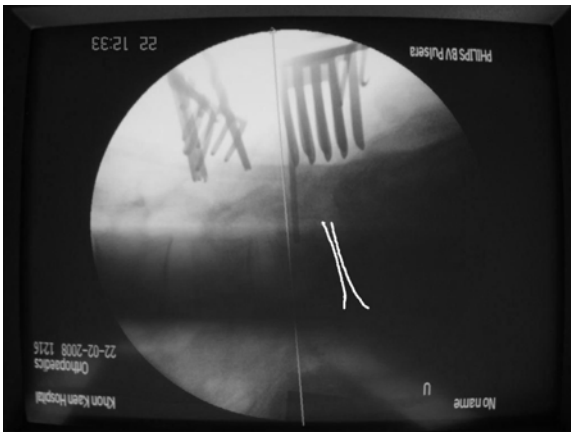

Fig. 4 Image of L-S spine lifted using KK-MTU during the operation from C-arm monitor after removal of all obstructed tissues and hanging 12 kg sand bags

patients were asked to identify the potential efficacy of the KK-MTU in terms of assisting spondylolisthesis surgery in relation to

1. Operation time
2. Blood loss
3. Anatomical clarification using the unit
4. Acceptance of
   a. Application of the unit
   b. Cauda equina and nerve root decompression
   c. Application of spinal instruments
   d. Fixation
5. Complications of using the unit

Data procedure and collection

The efficacy of using the KK-MTU in terms of operation time and blood loss was retrieved from the operative notes of 50 surgeries. In addition to this, a piloted semi-structured questionnaire was used to identify the efficacy based on fourteen surgeons' opinions of using the unit. Before proceeding to the analysis, all data both from the medical records were tested for logical consistency set up in the coding specification and were checked for wide codes by generating a frequency distribution for each variable by the researcher. Any missing data was validated when possible by comparing with the original copy of the patient records.

Data analysis

SPSS software program was used for statistical analysis (Version 15.0; SPSS Inc., Chicago, IL, USA). Frequency tables were presented together with percentages while mean values and standard deviations were shown if appropriate. Parameters were tested univariately for difference between pre- and post-test group. Parameters were classified and then tested if applicable. Comparison of the two groups was performed using Pearson's chi-square Test. P-values < 0.05 were considered significant.

Ethics approval

The present study was approved by the Ethics Committee for Research in Humans, Khon Kaen Hospital.

Results

The 50 patients who underwent the spondylolisthesis operation assisted by the KK-MTU were equally male and female (52% and 48% respectively) with a mean age of 57.9 years old (Table 1). Nearly half of the orthopedic surgeons performed posterior lumbar inter-body fusion while the other half preferred posterolateral fusion. Nearly all of the patients had the degree of subluxation less than 25% (grade I), and mostly caused by spondylolysis (isthmic type). Only 30% of the patients had been found to have other underlying diseases such as diabetes and hypertension. However, only 8% were also diagnosed with osteoporosis.

From the operative notes and opinions of surgeons regarding possible efficacy of KK-MTU, it has been found that the mean operative time was 148.6 minutes with the average blood loss of about 350 cc in 50 operations (Table 2). However, these numbers depended on the experience of the surgeons and

Table 1. Demographic characteristic of participants

Characteristics	Participants (n = 50)
Gender: n (%)	
Male	26 (52)
Female	24 (48)
Mean Age: Year (SD)	57.9 (5.9)
Type of surgery: n (%)	
Posterior lumbar inter-body fusion	23 (46)
Posterolateral Fusion	27 (54)
Degree of spondylolisthesis: n (%)	
Grade I	46 (92)
Grade II	3 (6)
Grade III	1 (2)
Type of spondylolisthesis: n (%)	
Isthmic	47 (94)
Dysplastic	2 (4)
Degenerative	1 (2)
Underlying disease: n (%)	
Hypertension	8 (16)
Diabetes	2 (4)
Osteoporosis	4 (8)

SD = standard deviation

Table 2. Treatment outcome of spondylolisthesis assisted using KK-MTU

Treatment outcome	Outcomes of operation (n = 50) and doctor opinions (n = 14)
Operation time: Minutes (SD)	148.6 (30)
Blood loss: cc (SD)	348 (140.7)
Opinion about operative time using KK-MTU: n	
Less time	14
More time	0
No different	0
Opinion about blood lost using KK-MTU: n	
Less blood lost	14
More blood lost	0
No different	0
Anatomical clarification using the unit: n	
Worse clarification	0
Better clarification	14
No different	0
Application of the unit: n	
Easy	14
Difficult	0
Acceptance of cauda equina and nerve root decompression: n	
Worse acceptance	0
Better acceptance	14
No different	0
Acceptance of application of spinal instruments: n	
Worse acceptance	0
Better acceptance	14
No different	0
Acceptance of fixation: n	
Worse acceptance	0
Better acceptance	14
No different	0
Complications of using the unit: n	
Rarely	14
Sometimes	0
Usually	0
Always	0

degree of difficulty of the operation. All the surgeons agreed that the KK-MTU was helpful in the clarification of the anatomy, easiness of application of the unit, acceptance of the decompression, reduction, fixation, and application of the spinal instruments with few complications.

When the surgeons were asked to state the promising advantages and complications that might arise from using KK-MTU, they reported that the unit could assist them in many ways as shown in Table 3. The main reasons were that the unit made the operation field clearer, so that the surgeon can decompress the spinal canal contents and apply the pedicular screws easier. This reduced the operation time and blood loss. However, a few complications were also mentioned. This included obscured operation field as it put more instruments in the operation field; slip out of the Kocher clamps as this unit has to apply the pulling effect through the Kocher clamps; and fractures of the spinous process in osteoporosis patients.

X-ray film in Fig. 3 shows grade II-III spondylolisthesis of L5-S1 in a 60-year-old man before surgery, and Fig. 4 exemplifies the application of KK-MTU traction unit in the operation field. During the operation, scars, facet joints, and disc spaces of L5-S1 were removed. Later, L5 was lifted gradually by applying continuous pulling forces through KK-MTU at the L3-4, which is cephalic to the lesion level.

Discussion

As the unit was newly invented, efficacy is also debatable. This clinical trial without control tried

Table 3. Advantage and disadvantage of using KK-MTU

Possible advantages	Possible complications
Decompression can be performed easier because diseased spine will not drop further anteriorly during decompression	Fracture of the pulled spinous process (1 case) which can be avoided by apply Kocher clamps pinching to 2 spinous processes above deformity level and not make side to side motion when maneuver Kocher clamps
Scar and diseased segment can be identified easier by make up and down movement of the spines through pinching Kocher. Motion makes it clearer to identify important structure underneath	Slip off from spinous process of the Kocher clamp but this can be reduced by using 2 or more Kocher clamps
The continuous elevating force lessen pressure to abdomen so make less bleeding surgery	Kocher clamps may obstruct working in the direction when instrument must be swing cross Kocher clamp
The continuous elevating force also is very flexible when we do some procedure that push or pull spines. The sand bags and long lever that hold pulleys make the system act as spring. So make fewer traumas to spinous processes and less possibilities to slip out of the Kocher clamps which are being pulled	Sterile rope may obstruct surgeon head when he wants to look over the wound to view opposite side
When Posterior Lumbar Interbody Fusion is prepared, after disc is removed and Facet joints are removed. The spine will not drop anteriorly and make it safer to apply pedicular screws	
The little cephalad direction of pulling force also open disc space and it is easier to prepare disc space for reduction and grafting	

to document the possible usefulness of the unit. It has been found that the unit can assist surgeons in relation to safe decompression done due to better clarification of anatomic plane through Kocher clamp maneuver. Moreover, reduction was found to be better than before because while applying the pedicular screws and rods, the diseased spine was under some reduction force by pulling the Kocher clamps. Entry point of the pedicular screws at the listhetic spine was pulled superficially and could be seen clearly, making screw application easier.

All orthopedists in the present study were general orthopedic surgeons. Therefore, their experiences in spine operation were varied. The outcomes of operation such as bleeding, operative time, quality of decompression and amount of reduction are incomparable. The present study aimed only to identify the easiness of operation procedure by using KK-MTU. The most severe case in the present study was grade II-III spondylolisthesis that might differ from previous studies[7] where anterior and posterior reduction and stabilization were needed.

To establish the efficacy of this KK-MTU, clinical trials phase II or III are required for more insight of the instrument. Both usefulness and complications must be studied before recommending it to use on other patients that might differ from what the authors have observed in the present trial. Development of protocol related of using the equipment is also needed.

In conclusion, this study suggest that an advanced operation such as spondylolisthesis surgery can be assisted by using a simple, locally built, device such as KK-MTU. The consensus of its efficacy has been made in relation to clarification of the anatomy, ease of application of the unit, acceptance of the decompression, reduction, fixation and application of the spinal instruments with few complications.

Potential financial conflicts of interest

None

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ประสิทธิผลของเครื่องดึงแบบประดิษฐ์ใช้เองในโรงพยาบาลชนิดเคลื่อนที่ได้ ในการช่วยผ่าตัดแก้การกดประสาทสันหลัง,จัดกระดูกเข้าที่และยึดตรึงกระดูกด้วยโลหะในการผ่าตัดกระดูกสันหลังส่วนเอว

ประสิทธิ์ หาญพินิจศักดิ์

วัตถุประสงค์*: เพื่อประเมินประโยชน์ของเครื่องดึงแบบเคลื่อนที่ได้ แบบประดิษฐ์ใช้เอง (KK-MTU) ในการช่วยการผ่าตัดกระดูกสันหลังส่วนเอวเลื่อนชนิดเคลื่อนไปข้างหน้า (anterior spondylolisthesis)*

วัสดุและวิธีการ*: โดยใช้แบบสอบถามแพทย์ 14 ท่านในกลุ่มงานออร์โธปิดิกส์ โรงพยาบาลศูนย์ขอนแก่น ที่ทำการผ่าตัด spondylolisthesis ตั้งแต่วันที่ 6 มกราคม พ.ศ. 2549 ถึงวันที่ 11 ธันวาคม พ.ศ. 2550 จำนวนผู้ป่วย ที่ได้รับการผ่าตัด 50 ราย*

ผลการศึกษา*: ผู้รายงานได้ออกแบบเครื่องมือนี้และใช้ช่วยผ่าตัดมาตลอดเวลากว่า 20 ปี และปัจจุบันแพทย์ทุกท่านที่ผ่าตัดกระดูกสันหลังได้มีโอกาสใช้เครื่องมือนี้ ผู้รายงานได้ออกแบบสอบถามศัลยแพทย์ เพื่อประเมินประโยชน์ของเครื่องมือนี้ในแง่ต่าง ๆ ผลคือ การใช้เครื่องมือนี้ทำให้ การ decompression ง่ายขึ้น เพราะเมื่อโยก Kocher ขึ้นลง ทำให้เห็น plane และ anatomy ของการผ่าตัดชัดเจนขึ้น เลือดออกน้อยลง จากการที่แรงดึงยกของเครื่องมือช่วยลดความดันที่มีต่อท้องผู้ป่วย การใส่ pedicular screws ง่ายขึ้นเพราะจุดที่ใส่ screws ถูกดึงให้ตื้นขึ้นมา การใส่แท่งโลหะเพื่อยึด screws ง่ายขึ้นเพราะกระดูกสันหลังได้ถูกดึงเข้าที่แล้วบางส่วน ทำให้ตัว screws ไม่ถูกดึงมากจนเกลียวที่กระดูกรูดอันเป็นสาเหตุให้เสียความแข็งแรงในการยึดตรึงกระดูก*

สรุป*: การใช้เครื่องมือนี้ช่วยศัลยแพทย์ผ่าตัดกระดูกสันหลังส่วนเอวได้ง่ายขึ้นมาก และลดการเกิดผลแทรกซ้อนที่เกิดจากความยากในการผ่าตัดโรคกระดูกสันหลังส่วนเอวเลื่อนไปข้างหน้า ยังไม่มีการรายงาน การใช้เครื่องลักษณะเช่นนี้มาก่อน*