



The Thai Journal *of* Orthopaedic Surgery



**The Official Journal of
the Royal College of
Orthopaedic Surgeons of Thailand**

**The Official Journal of Thai Hip & Knee Society
The Official Journal of Spine Society of Thailand
The Official Journal of Thai Orthopaedic Society for Sports Medicine
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Editorial

The Thai Journal of Orthopaedic Surgery, volume 41 no. 3-4, has been launched during the RCOST meeting on the 20th to the 22nd October 2017 at Pattaya Exhibition and Convention Hall, Royal Cliff Hotels Group. This year is another very special, as we are preparing for the Royal Cremation of the beloved King Bhumibol Adulyadej on the 26th of October 2017. Nevertheless, our academic meeting of the Royal College of Orthopaedic Surgeons of Thailand, under the patronage of King Bhumibol Adulyadej, is aimed to exchange knowledge among orthopaedic surgeons by the theme “Wisdom comes with healthy ageing”. The Royal College also arranges social events for the unity of our members, who devoted themselves helping people around the country. This year, we have 3 members who will receive 3 awards, one for best service, one for best management and another for best academic progression. I would like to congratulate to all of their successes.

This volume consisted of various topic from trauma, spine and arthroplasty sections. The comparison of quality of life between fixation and arthroplasty in intertrochanteric fracture of femur in elderly patients by Yodsawee Pornmeechai. This research showed that the short term quality of life in arthroplasty group was higher than fixation group, but the incidence of mortality in both groups were as high as 25-38 percent after one year. Chote Pawasuttikul showed in his article that there was no function different between one or two levels fusion with pedicular screw fixation for single level spondylolisthesis of lumbar spines after 5 years follow up period. There were two cases reports in the treatment of difficult knee osteoarthritis with severe genu recurvatum by Kulapat Chulsomlee. The successful surgical treatment were done by using rotating hinge knee prosthesis which is a very interesting procedures. Another basic research is the estimation of Inter Iliac crest distance by ulna length measurement for reference in reduction of pelvic fractures by Satapong Pisuitthanakan. It is also interesting but the result was not yield good correlation.

I hope that the Thai Journal of Orthopaedic Surgery is a very useful ground for academic publication of our members and friends from ASEAN countries. The acceptance of our journal will be higher by the contribution of our members. Please submit your research in our journal.

Pongsak Yuktanandana, MD
Editor, The Thai Journal of Orthopaedic Surgery

Comparison of Quality of Life between Fixation and Arthroplasty in Intertrochanteric Fracture of Femur in Elderly Patients

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Background: Standard treatment for intertrochanteric fracture is internal fixation. Arthroplasty is an alternative treatment for these fractures in some specific conditions. Apart from hip functional score, health-related quality of life (HRQoL) is one of the interesting domains that can reflect the outcome of the treatment. However there are many conditions affecting HRQoL especially in the elderly patients.

Objective: To evaluate the HRQoL of the patients between treatment of intertrochanteric fracture in elderly with fixation and arthroplasty.

Materials and Methods: In this retrospective study, 143 intertrochanteric fracture patients who were treated during 2001-2015 were included. The patients were divided into 2 groups; 82 patients in fixation group and 61 patients in arthroplasty group. HRQoL between 2 groups were compared by EuroQol-5D-5L(EQ-5D-5L) index score at 3, 6 and 12 months postoperatively.

Results: The mean of EQ-5D-5L index score was significantly better in arthroplasty group than fixation group at 3 months (0.8 vs 0.6)($P < 0.05$) and 6 months (0.91 vs 0.78)($P < 0.05$) postoperatively. However, there was no significant difference at 12 months (0.94 vs 0.87)($P = 0.15$).

Conclusion: Arthroplasty in intertrochanteric fracture in elderly might give better quality of life than fixation in the early postoperative period.

Keywords: intertrochanteric fracture, hip arthroplasty, internal fixation, quality of life, HRQoL

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Introduction

Population tend to live longer due to development in modern medicine. The number of the elderly was increasing as well as the disease that associated with aging population such as hip fracture especially intertrochanteric fracture^(1,2).

Hip fractures deteriorate quality of life of patients because of prolonged hospital stay and rehabilitation. Independent daily activities are difficult especially in the developing countries which public facilities for handicap are not fully constructed^(3,4).

Today the standard treatment of intertrochanteric fractures is internal fixation. Non-weight bearing ambulation after internal fixation in elderly is very difficult. Arthroplasty is an alternative treatment that is purposed to be use in some patients such as severe osteoporosis, neoplasm and preexisting arthritis. However, there are a few reports about treating intertrochanteric fracture with arthroplasty^(5,6).

Most studies focus on function of the hip that could not directly reflect patient satisfaction^(7,8). The authors think that quality of

life is one of the important domain that can reflect patient satisfaction and also the successful surgical outcome. So this study was conducted to compare the quality of life between fixation and arthroplasty of intertrochanteric fracture in elderly⁽⁹⁾. The result of this study should give more knowledge and improvement of treatment of fracture in this region.

Materials and Methods

From 2001-2015, 445 patients with intertrochanteric fracture were treated at The King Chulalongkorn Memorial Hospital (KCMH) were included in this study. Inclusion criteria were patients with intertrochanteric fracture who underwent fixation or arthroplasty in KCMH, age of more than 65 years old, patients or patient's caregivers were able to understand and can complete all questionnaire. Exclusion criteria were patients with multiple trauma, pre-injury status was non-ambulatory and patient with psychiatric problems. One hundred and forty-three patients were included in this study. The patients were divided into 2 groups by a type of treatment (fixation vs arthroplasty) (Fig. 1). All of the patients were treated with 10 high experience orthopaedics surgeons. Decisions to perform fixation or arthroplasty in each patients were done by individual surgeons. Every patients received

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similar post-operative rehabilitation protocol specified according to the operative procedure.

The fixation group was consisted of 5 types of internal fixation: dynamic hip screw (DHS), proximal femoral nail (PFN), Ender nails, locking plate and angle blade plate (ABP). The arthroplasty group was consisted of 3 types: total hip arthroplasty (THA), bipolar hemiarthroplasty and unipolar hemiarthroplasty.

The EuroQol-5D-5L(EQ-5D-5L) index was used for evaluating quality of life of the patients⁽¹⁰⁾. An EQ-5D-5L index score of 0 indicates the worst possible health state, and a value of 1 indicates full health state. Five domains (Mobility, self-care, daily activity, pain and anxiety) that represent each categories of quality of

life were explained to the patients or the patient's caregiver. Then the patients or the patient's caregiver had to complete the questionnaire. Every patients were assigned to complete the questionnaire at 3, 6 and 12 month postoperatively.

Statistical analysis

The EQ-5D-5L score in each dimension was adjusted to utility score. Then sum of utility score in 5 dimensions was used for calculation. Difference of mean of utility score between 2 groups were analyzed with independents t-test. Comparison difference of proportion of sex between 2 groups by Chi-square test. Statistically significant was P -value < 0.05 .

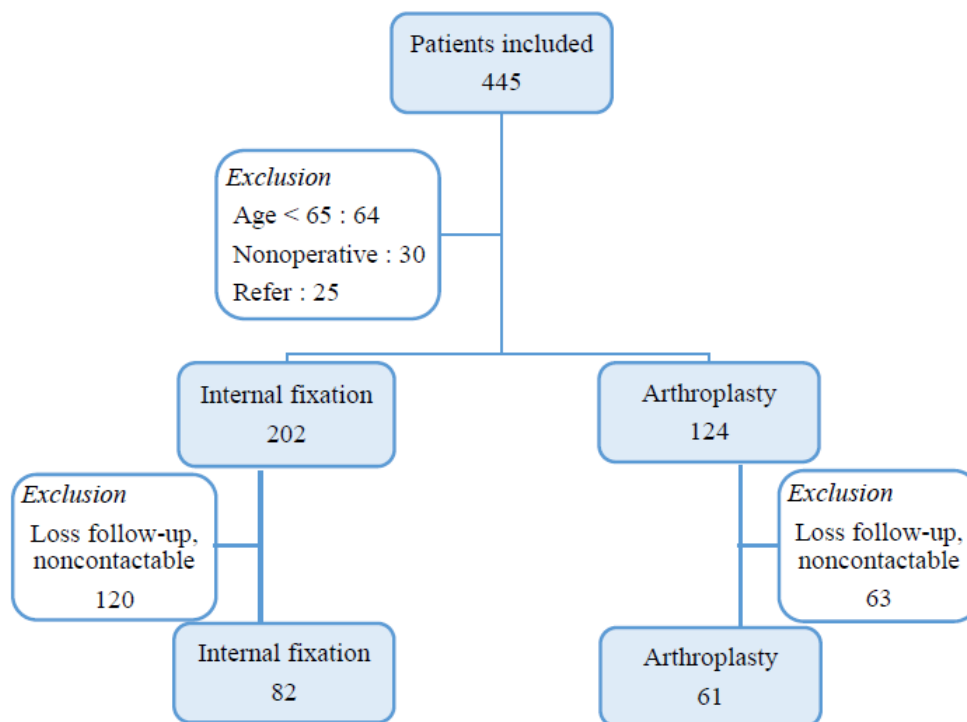


Fig.1 Intertrochanteric fracture patients treated in KCMH during 2001-2015

Results

Table 1. demonstrated the demographics data of the study population. There was high ratio of male patient in fixation group compared to arthroplasty group (32.9% vs 14.8%) ($P = 0.013$).

The EQ-5D-5L index score which reflex HRQoL was significantly better in arthroplasty group at 3 months, 6 months postoperatively ($P < 0.05$).(Fig.2) However at 12 months postoperatively, it was no significant difference in the score ($P = 0.15$). The EQ-5D-5L index score in both group increased significantly in every postoperative visit ($P < 0.001$)(Table 2).

In arthroplasty group, there were 3 THA, 27 bipolar hemiarthroplasty and 31 unipolar hemiarthroplasty. Because of limited number in THA, this study compared EQ-5D-5L score between bipolar and unipolar hemiarthroplasty. The authors found that there was no difference in EQ-5D-5L index score between bipolar and unipolar hemiarthroplasty group (Table 3).

In fixation group, there were 58 DHS, 5 PFN, 9 Ender nails, 1 locking plate and 9 ABP. We found that EQ-5D-5L index score in DHS group was less than ABP group at 3 months and 6 months postoperatively ($P < 0.05$). There was no statistically significant difference between DHS vs PFN and DHS vs Ender nail.

Table 1 Demographic data of the study population

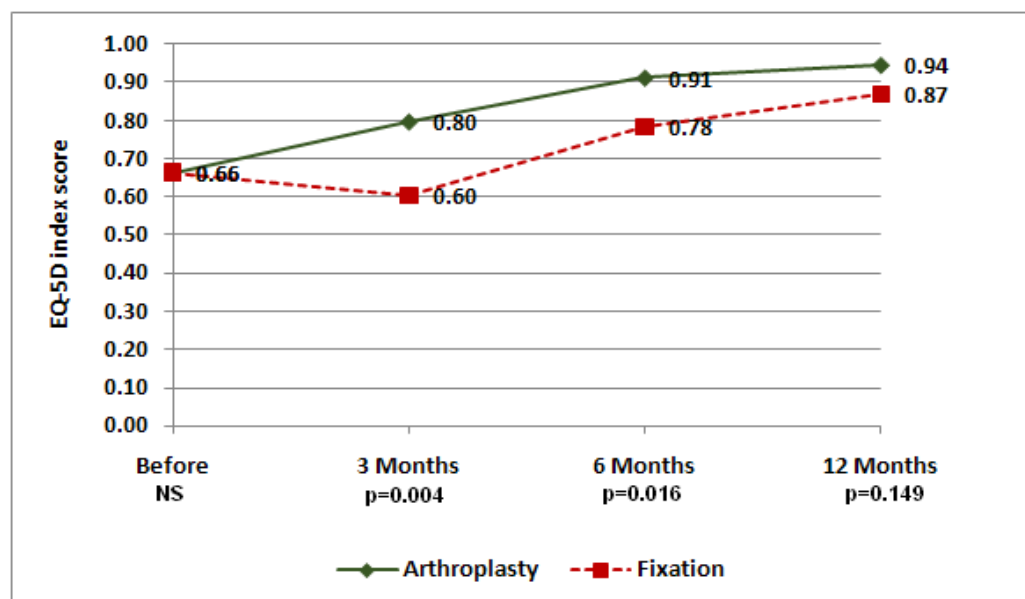
	Arthroplasty (n=61)	Fixation (n=82)	P-value
Sex			
Male	9 (14.8%)	27 (32.9%)	
Female	52 (85.2%)	55 (67.1%)	
Age (years), Mean±SD	80.51 ± 7.60	78.98 ± 7.46	0.230
Death	25 (41%)	38 (46.3%)	0.523

Values presented as n(%) and Mean±SD. P-value corresponds to Chi-square test

Table 2 Comparing EQ-5D-5L between arthroplasty and fixation group

Follow-up time	Type of surgery		P-value ⁽¹⁾
	Arthroplasty (n=61)	Fixation (n=82)	
3 Months	0.8 (0.51, 0.8)	0.6 (0.37, 0.78)	0.004*
6 Months	0.91 (0.63, 1)	0.78 (0.47, 0.91)	0.016*
12 Months	0.94 (0.66, 1)	0.87 (0.57, 1)	0.149
P-value ⁽²⁾	< 0.001*	< 0.001*	

Values presented as Median (IQR; percentile 25, percentile 75). P-value corresponds to ⁽¹⁾ Mann-Whitney test (Between group) and ⁽²⁾ Wilcoxon Signed Ranks Test (Within group)

**Fig. 2** EQ-5D-5L score between arthroplasty and fixation group at 3 months, 6 months and 12 months**Table 3** Comparison quality of life in arthroplasty group

Follow-up time	Type of surgery		P-value
	Bipolar (n = 27)	Unipolar (n = 31)	
3 Months	0.8 (0.6, 0.8)	0.8 (0.42, 0.8)	0.622
6 Months	0.89 (0.61, 0.91)	0.91 (0.56, 1)	0.448
12 Months	0.94 (0.66, 1)	0.91 (0.6, 1)	0.987
P-value	0.002*	< 0.001*	

Values presented as Median (IQR; percentile 25, percentile 75). P-value corresponds to Mann-Whitney test (Between group) and Wilcoxon Signed Ranks Test (Within group)

Discussion

An intertrochanteric fracture is one of the most common fracture around the hip as well as femoral neck fracture. The standard treatments are internal fixation with DHS or PFN. Many complications were reported such as fixation failure, malunion and non-union especially in osteoporotic bone. Non-weight bearing after fracture fixation in elderly were troublesome. Alternative treatments such as arthroplasty might have benefit because patients can do early weight bearing. We think that quality of life in arthroplasty group should be better than fixation group.

This study was the first study to compare health related quality of life of elderly patients with intertrochanteric fracture which underwent fixation and arthroplasty. All previous studies reported results with organ specific scoring (eg. Harris hip score). The results of these studies varied in favor among arthroplasty and fixation^(7,18,19). Our study showed that arthroplasty gave better quality of life in early postoperative period (< 6 month). This might be explained that patients in arthroplasty group were less painful, patients could ambulate faster and better than in fixation group.

This study had limitations. First, it was a retrospective study in which many data were inhomogeneous such as various technique in fixation and arthroplasty groups and there were many incomplete data such as classification of fracture, comorbid diseases, and perioperative complications. And also, some data were recalled more than 5 years. Second, selection bias may be presented that patients with more stable fracture pattern were more likely to be treated with internal fixation than those with unstable fracture pattern that tend to be treated with arthroplasty. It was also difference in male and female proportion between two groups. Third, we do not have the data about the pre-injury ambulatory status that might affect the postoperative rehabilitation program. Last, small number of sample size may reduced the power of this study.

Primary arthroplasty in intertrochanteric fractures in elderly provided good results due to early ambulation^(12,13-17). Many studies showed better clinical outcome in arthroplasty than internal fixation^(7,18). However some studies show no significant difference between 2 groups⁽⁸⁾. In contrast some studies show better clinical results in fixation group⁽¹⁹⁾.

Our study concludes that arthroplasty in intertrochanteric fracture in elderly might give better quality of life than fixation in the early postoperative period (< 6 month). This might help surgeons to select proper choice of treatment in elderly patients with fracture in this region. However the future study should be collected all of

important data that may affect the results and should be prospective method.

Conclusion

Arthroplasty in intertrochanteric fracture in elderly might give better quality of life than fixation in the early postoperative period.

Potential conflicts of interest

None.

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การเปรียบเทียบคุณภาพชีวิตของผู้ป่วยที่มีกระดูกสะโพกหักที่รักษาด้วยวิธีผ่าตัดตามกระดูกและการผ่าตัดเปลี่ยนข้อเทียม

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วัตถุประสงค์: เพื่อศึกษาคุณภาพชีวิตของผู้ป่วยกระดูกสะโพกหัก (*intertrochanteric fracture*) ที่รักษาด้วยวิธีการผ่าตัดยึดตามกระดูกด้วยโลหะ ซึ่งเป็นวิธีการรักษาตามมาตรฐานทั่วไป เปรียบเทียบกับการรักษาด้วยการผ่าตัดเปลี่ยนข้อสะโพกเทียม

วิธีการศึกษา: เก็บรวบรวมข้อมูลผู้ป่วยกระดูกข้อสะโพกหัก (*intertrochanteric fracture*) ย้อนหลังตั้งแต่ปี พ.ศ.2543 ถึง พ.ศ.2558 ที่รักษาด้วยวิธีการผ่าตัด ได้ทั้งสิ้น 143 ราย แบ่งเป็นการรักษาด้วยวิธีผ่าตัดยึดตามกระดูก 82 ราย และวิธีผ่าตัดเปลี่ยนข้อสะโพกเทียม 61 ราย โดยเปรียบเทียบคุณภาพชีวิตหลังการผ่าตัดรักษาที่เวลา 3, 6 และ 12 เดือน โดยใช้แบบสอบถาม *EuroQol-5D-5L(EQ-5D-5L)* ฉบับภาษาไทย

ผลการศึกษา: ค่าเฉลี่ยของคะแนน *EQ-5D-5L* ของผู้ป่วยกลุ่มที่ผ่าตัดด้วยวิธีการเปลี่ยนข้อสะโพกเทียม มีคะแนนมากกว่ากลุ่มที่ผ่าตัดด้วยการตามกระดูกอย่างมีนัยยะสำคัญหลังจากผ่าตัดไปแล้ว 3 เดือน (0.8 vs 0.6) ($P < 0.05$) และ 6 เดือน (0.91 vs 0.78) ($P < 0.05$) อย่างไรก็ตามหลังจากผ่าตัดไปแล้ว 12 เดือน คะแนนของทั้งสองกลุ่มไม่แตกต่างกัน (0.94 vs 0.87) ($P = 0.15$)

สรุป: การรักษาผู้ป่วยกระดูกสะโพกหักด้วยวิธีการผ่าตัดเปลี่ยนข้อสะโพกเทียม น่าจะทำให้ผู้ป่วยมีคุณภาพชีวิตที่ดีกว่าการรักษาด้วยวิธีการผ่าตัดยึดตามกระดูกด้วยโลหะ ในช่วงเวลา 6 เดือนหลังจากผ่าตัด

Effect of Single and Two Level Posterior Instrumented Fusion for L4-5 Degenerative Spondylolisthesis with Adjacent Spinal Stenosis

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Backgrounds: Pedicular screw fixation is the most popular system in instrumented arthrodesis in the lumbar spine. Long-term important complication after lumbar fusion is adjacent segment disease (ASD). The incidence of symptomatic ASD was 5.2-18.5%. Normal progression of degenerative disease and biomechanical alteration played an important role in this disease. However, the cause of ASD is not clear. It has been an attempt to find ways to prevent ASD such as arthroplasty, dynamic fixation and percutaneous fixation. However, it has not been found the effective method. Because adjacent spinal stenosis above single level fusion may increase risk of ASD, therefore we hypothesize that ASD rate will be decrease if we extend spinal fusion to adjacent level.

Purpose: To determine the clinical outcome, particularly in the presence ASD, which led to the second operation in patients with degenerative spondylolisthesis of L4-5 and multilevel lumbar stenosis treated with PLF and pedicular screw fixation at L4-5 compare with PLF, Pedicular screw fixation at L4-5 and prophylaxis fixation at L3-4.

Methods: 67 patients with degenerative L4 spondylolisthesis (grade I-II) and spinal canal stenosis at L3-5. Group 1, 32 patients underwent L4-5 PLF and pedicular screws fixation in 2007-2010, Group 2, 35 patients underwent PLF, pedicular screws fixation at L4-5 and prophylaxis fixation at L3-4 in 2011-2013. Based on the obtained data from the patients, pre-operatively, immediately after surgery and at the time of follow-up at 3 months, 6 months, 1 years and then annually afterward including age, sex, BMI, visual analog pain scores (VAS), Oswestry Disability Index (ODI), the occurrence of ASD and the second operation. The data were analyzed by descriptive statistic, Chi-square test and student's t-test.

Results: Surgery patients age average of 55.76 years (range 37-69 years). The mean follow-up period was 65.64 months (range 63-72 months). The recovery rate of VAS score and ODI were not significantly different between the two groups. The lumbar lordosis after operation was decrease in both groups. There were angulation, translation, and decreased disk height at the level above the fusion in both groups but it is not significantly different. Single level fusion group found that grade of listhesis and BMI is a factor affecting ASD ($P < 0.05$). For the two level fusion groups, the four factors, age, gender, grade of listhesis and BMI did not affect ASD. The occurrence of ASD in single level fusion group at L3-4 level in 4 cases (12.5%). Two level fusion group found ASD at L2-3 level in 1 cases (2.85%). The occurrence of ASD between two groups were not significantly different.

Conclusion: There is not significantly different in functional outcome between single level or two level fusion with pedicular screws fixation in treatment of patients with degenerative L4 spondylolisthesis and multilevel lumbar stenosis. It cannot be concluded that two level fusion with pedicular screws fixation was the effective way to prevent ASD on cranial segment.

Keywords: lumbar spondylolisthesis, pedicular screw fixation, adjacent segment disease

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Introduction

The outcome of the operative treatment of degenerative lumbar spondylolisthesis associated with spinal stenosis is better than nonoperative treatment. It was found that greater pain relief and improvement in function for four years⁽¹⁾. The choices of surgery include decompression alone, decompression and fusion with or without instru-

mentation. While decompression with fusion had superior results over decompression alone⁽²⁾. Key objective of instrumentation are to increase the rate and degree of fusion, correct deformities, provide initial stability resulting in better recovery to return to activities^(3,4).

Degenerative spondylolisthesis is one of the indications for instrumentation fusion and the pedicular screw fixation is the most popular system in instrumented arthrodesis in the lumbar spine⁽⁴⁾. There were guidelines for appropriate levels of instrumentation but there has no definite conclusion

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for degenerative spondylolisthesis of L4-5 and multilevel lumbar stenosis^(5,6).

Long-term important complication after lumbar fusion are adjacent segment disease (ASD). ASD refers to the degeneration of adjacent segment leading to clinical symptoms that require further treatment, whereas adjacent segment degeneration is a finding of the radiographic changes of the intervertebral discs adjacent to the fusion levels and have no significant symptom⁽⁷⁾. The incidence of ASD according to radiographic criteria was 8-100%, while the reported symptomatic ASD was 5.2-18.5%⁽⁸⁾ Ghiselli et al reported the incidence of ASD after the index decompression or arthrodesis was 16.5% at five years and 36.1% at ten years⁽⁹⁾. The cause of ASD is not clear. Based on a review of the literature by Park et al, it is concluded that normal progression of degenerative disease and biomechanical alteration played an important role in this disease⁽⁸⁾.

Several studies of the risk factors, surgical factor include the application of instrumentation, type of instrument, length of fusion (especially three or more levels), facet joint destruction, loss of lumbar lordosis and sagittal and coronal imbalance. And patient factor include age, gender, BMI, BMD, preexisting degeneration of adjacent disks, sagittal alignment, laminar incination, sacral incination and facet tropism. Still can not conclude what factors affect ASD?⁽¹⁰⁻¹²⁾ Hikata et al. Reported in 2014 that the sagittal angle of the facet joint was a factor that affected symptomatic ASD⁽¹³⁾.

It has been an attempt to find ways to prevent ASD such as arthroplasty, dynamic fixation and percutaneous fixation.

However, it has not been found the method to prevent statistically significant and long-term results are also unavailable⁽¹⁴⁻¹⁶⁾. Because adjacent spinal stenosis above single level fusion may increase risk of ASD, therefore we hypothesize that ASD rate will be decrease if we extend spinal fusion to adjacent level⁽¹⁷⁾. The objective of this study was to determine the clinical outcome, particularly in the presence ASD, which led to the second surgery. In patients with degenerative spondylolisthesis of L4-5 and multilevel lumbar stenosis treated with PLF and pedicular screw fixation at L4-5 compare with PLF, pedicular screw fixation at L4-5 and prophylaxis fixation at L3-4.

Patients and Methods

76 patients with degenerative L4 spondylolisthesis (grade I-II) has been diagnosed by computed tomography scan, myelography, CT-myelography or magnetic resonance imaging. The inclusion criteria are patients with L4-5 spondylolisthesis and spinal canal stenosis at L3-5. All patients were treated with PLF and pedicular screws fixation (Xia system) between 2007 and

2013. Patients who were postoperative follow-up period of less than 60 months, non-compliance, or incomplete data were excluded. The remaining 67 patients (30 male and 37 female) were included in the study. The mean age of 55.76 years at surgery (range 37-69 years). The mean follow-up period was 65.64 months (range 63-72 months). This retrospective study was approved by the Ethics Committee of Sawanpracharak Hospital.

Surgical technique

Group 1, 32 patients underwent PLF and pedicular screws fixation at L4-5 in 2007-2010, Group 2, 35 patients underwent PLF, pedicular screws fixation at L4-5 and prophylaxis fixation at L3-4 in 2011-2013. All surgeries were performed by a single surgeon from January 2007 to December 2013. The surgery started with routine posterior midline incision. Laminectomy was performed, decompression was done by total resection of the ligamentum flavum, lateral recess were decompressed by carefully resected medial aspect of facet joint less than 50% of total. The pedicular screws were placed to correct the sagittal and coronal alignment of the lumbar spine and reduced spondylolisthesis as much as possible. Confirmed position of pedicular screws by radiography. PLF were performed by autogenous bone grafts from the resected spinous process at each level.

The data for the patients were obtained, pre-operatively, immediately after surgery and at the time of follow-up at 3 months, 6 months, 1 years and then annually afterward. Including age, sex, BMI, visual analog pain scores (VAS), Oswestry Disability Index (ODI), the occurrence of ASD and the second operation.

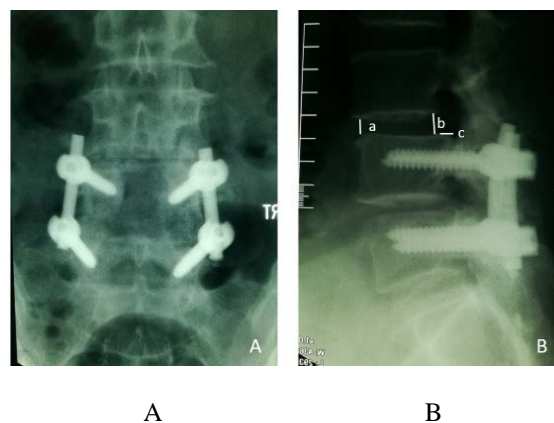


Fig.1 Imaging measurement A. AP static view
B. Lateral static view

- 1) Disc height has been measured as $(a+b) / 2$
- 2) Translation has been measured as the distance of c (The distance on superior end plate of the lower vertebral body between the posterior margin of vertebral column) in flexion-extension view.

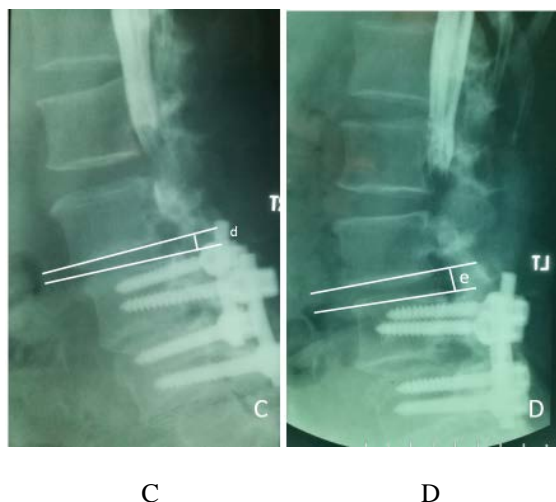


Fig.2 Imaging measurement angulation by angle between two adjacent end-plates (d and e) in flexion-extension view (C and D)

Radiologic assessment was performed, AP and lateral static plain radiography and flexion-extension radiography to detect the instability, on the basis of comparison with pre-operative and post-operative lateral radiographs including lumbar lordosis, transitional motion > 4 mm in flexion/extension and angular motion > 10 mm.^(3,4) and disc height at the level above the fusion. Criteria for diagnostic ASD were disc degeneration (loss of disc height, disc space narrowing), listhesis (anterolisthesis, retrolisthesis), instability, herniated nucleus pulposus, stenosis, hypertrophic facet arthritis, osteophyte formation scoliosis, and vertebral compression fracture⁽⁸⁾. (figure 1 and 2)

The primary outcome were ODI and VAS. By using The Oswestry Low Back Pain Disability questionnaire (Version1.0) Thai Version⁽¹⁸⁾. Reduction of ODI at least 15% indicates a successful clinical outcome by the criteria of the US FDA⁽¹⁹⁾.

The data were analyzed by descriptive statistic. Compared the base line characteristics and the results of treatment between group by Chi-square test for discrete data and student's t-test for continuous data. Analysis was performed with STATA 10, statistic significant at $P < 0.05$.

Result

There were no significantly different in demographic data, sex, age, grade of listhesis, BMI and the average follow-up period between two groups. Data are shown in table1. No serious neurological complication or deep surgical site infection. Dura tear occurred intra- operatively in 5 patients. All were repaired and no further complications have been found. Two patients in group one had re-operative from misplaced screws. There were no pseudarthrosis or implants remove at the last follow-up examination. The lumbar lordosis after operation was decrease in both groups. There were angulation, translation, and decreased disk height at the level above the fusion in both groups but no significantly different. Data are shown in table 2. Clinical outcome form ODI and VAS score were not significantly different between the two groups. Single level fusion group found that grade of listhesis and BMI is a factor affecting ASD ($P < 0.05$). For the two level fusion groups, the four factors, age, gender, grade of listhesis and BMI did not affect ASD. Data are shown in table 3 and 4.

ASD was found in single level fusion group at L3-4 level 4 cases. All were loss of disc height. Anterior listhesis in 3 cases and retholisthesis in 1 case. Two level fusion group was found ASD at L2-3 level in 1 cases which have severe angulation and loss of disc height. Second operation was performed in 5 cases. The mean period between the first surgery and the second surgery was 21 months (range from 13-27 months) in single level fusion group and 58 months in two level fusion group. (figure 3 and 4)

Table 1 Demographic Data

	Single level fusion	Two level fusion	P-value
Number	32	35	
Sex			
Male	16 (50.00)	14 (40.00)	0.411
Female	16 (50.00)	21 (60.00)	
Age	54.31 (7.54)	57.22 (7.05)	0.107
Grade of listhesis			
Gr I	18 (56.25)	31 (88.5)	0.493
Gr II	14 (43.75)	4 (11.5)	
BMI	23.09 (2.46)	22.68 (2.51)	0.505
Average follow-up	65.84 (2.98)	65.45 (2.45)	0.563

Table 2 Outcome of treatment

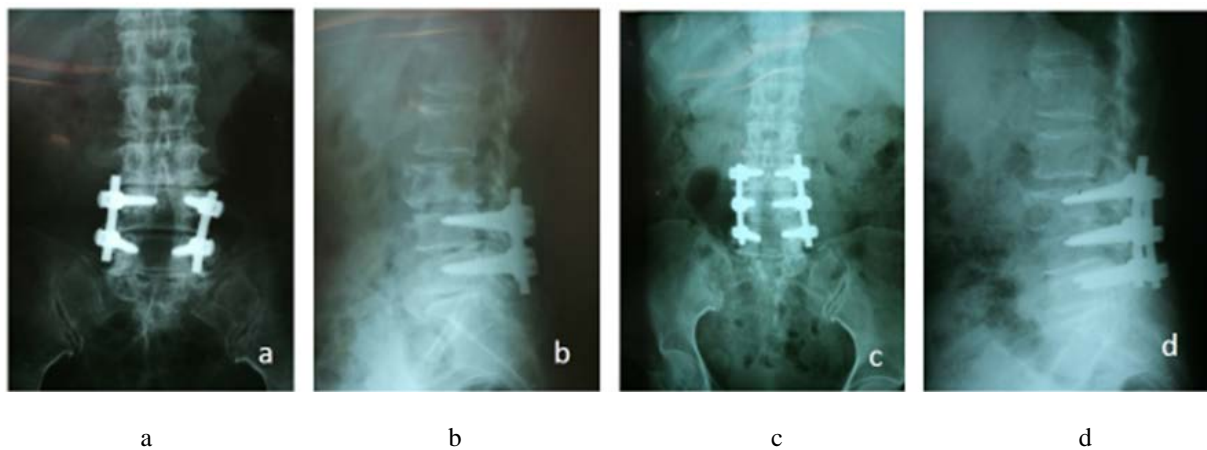
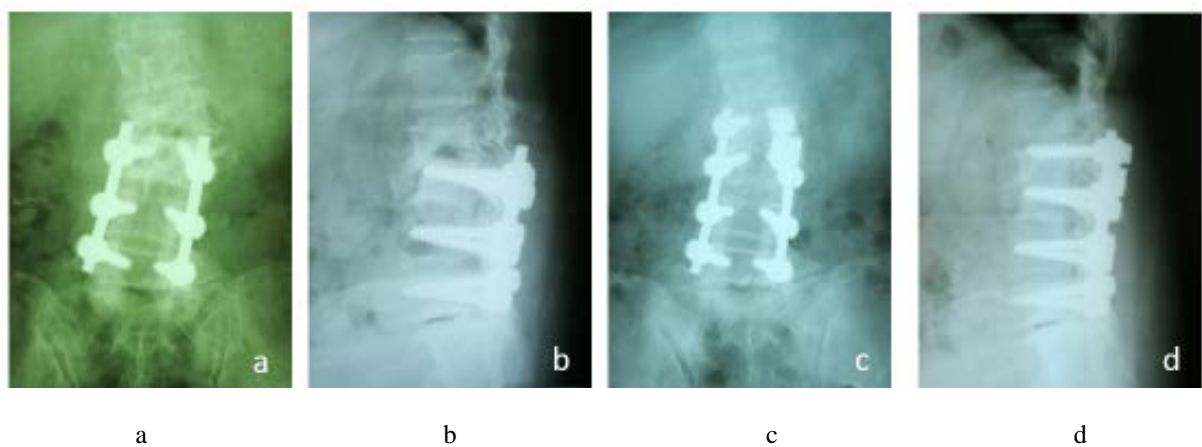
	Single level fusion	Two level fusion	P-value
Number	32	35	
Lordosis			
Pre-op	52.78 (8.69)	50.37 (7.46)	0.761
Post-op	48.34 (8.51)	47.94 (8.35)	0.766
VAS			
Pre-op	8.96 (0.60)	8.72 (0.51)	0.076
3 months	5.45 (0.56)	4.97 (0.77)	0.001
6 months	4.74 (0.68)	4.38 (0.64)	0.033
1 year	3.35 (0.55)	3.13 (0.35)	0.056
5 years	1.83 (0.58)	1.63 (0.59)	0.170
ODI			
Pre-op	40.09 (2.66)	39.94 (2.94)	0.826
3 months	31.45 (3.02)	31.47 (2.64)	0.976
6 months	26.54 (2.97)	26.55 (1.94)	0.990
1 year	22.32 (1.79)	21.83 (1.85)	0.279
5 years	21.83 (2.49)	19.61 (1.62)	0.170
Angulation			
Pre-op	0	0	
F-U	2.75 (3.75)	2.08 (5.15)	0.551
Translation			
Pre-op	0	0	
F-U	0.68 (1.20)	0.48 (1.09)	0.474
Disk height			
Pre-op	10.03 (1.65)	9.08 (1.17)	0.05
F-U	7.96 (2.23)	7.14 (1.88)	0.73
Second operation form			
Symptomatic ASD			
Yes	4 (12.5%)	1 (2.85%)	0.13
No	28 (87.5%)	34 (97.15%)	

Table 3 Factors affecting ASD in Single level fusion

Factors	No ASD (N=28)		ASD (N=4)		P-value
	Number	Percent	Number	Percent	
Sex					0.788
Male	12	42.86	2	50.00	
Female	16	57.14	2	50.00	
Age (year)					0.662
< 40	1	3.57	0	0.00	
41-50	7	25.00	2	50.00	
51-60	15	53.57	1	25.00	
61-70	5	17.86	1	25.00	
Grade of listhesis					0.054
Gr I	14	50.00	4	100	
Gr II	14	50.00	0	0.00	
BMI					0.013
< 18.5	0	0.00	1	25.00	
18.5-24.9	20	71.43	1	25.00	
25.0-29.9	8	28.57	2	50.00	

Table 4 Factors affecting ASD in two level fusion

Factor	No ASD (N=34)		ASD (N=1)		P-value
	Number	Percent	Number	Percent	
Sex					0.407
Male	14	41.18	0	0.00	
Female	20	58.82	1	100	
Age (year)					0.808
< 40	4	11.76	0	0.00	
41-50	17	50.00	1	100	
51-60	10	29.41	0	0.00	
61-70	3	8.82	0	0.00	
Grade of listhesis					0.764
Gr I	30	88.50	1	100	
Gr II	4	11.50	0	0.00	
BMI					0.612
< 18.5	0	0.00	0	0.00	
18.5-24.9	27	79.41	1	100	
25.0-29.9	7	20.59	0	0.00	

**Fig.3** Imaging studies of ASD in single level fusion. Preoperative (a,b) and postoperative (c,d)**Fig.4** Imaging studies of ASD in two level fusion. Preoperative (a,b) and postoperative (c,d)

Discussion

Degenerative spondylolisthesis usually has multi-level disc or facet degeneration which cause ASD in the future. Based on Choon Sung Lee et al report, there is a correlation between preexisting disc and facet degeneration and ASD⁽¹⁰⁾. Beside, Hikata et al reported that sagittal orientation of the facet joint at L3/4 is the risk factor for the development of symptomatic ASD ($P < 0.024$)⁽¹³⁾. Yet, some patients in this study did not have CT myelogram therefore there is a lack in information about facet sagittalization.

Altered biomechanical that cause ASD is described in two theories, adjacent intradiscal pressure increase 45% in instrumented posterior fusion and loss of ROM of the fused segments cause torque in adjacent level. However, there still cannot demonstrate the relationship between increase ROM and intra discal pressure among fusion and control group^(8,20). Prophylaxis pedicular screw fixation at L3-4 in this study found ASD 2.85% compared to single level fusion found ASD 12.5% but no significant difference was found. There should be prospective RCT studies in sufficient number of patients to provide more accurate results. The most common finding of adjacent segment disease was disc degeneration. The other were listhesis, instability, hypertrophic facet joint arthritis, and stenosis^(8,13). Referring to 5 patients in the study, they all have disc space narrowing and instability. 4 patients have anterior listhesis and one has retrolisthesis. The average interval between the index and second surgery was 52.3 months (range from 9 -1 2 5 months)⁽⁹⁾. However, the incidence is expected to increase with longer follow-up. In this study, the average interval between the index and second operation in two level fusion (58 months) was longer than single level (21 months).

On the clinical outcome, VAS score was significantly improved at 3-12 months in both groups. Then, in 1 to 5 years, the level of pain was relatively constant. For ODI, it has been found to improve over 15% in both groups since the third month and there is no significantly difference between the two groups. This study is similar to that of Yossi Smorgicket al.⁽⁶⁾ which study comparison between single level fusion and multilevel fusion.

This study found that factor affecting ASD ($P < 0.05$) was grade of listhesis and BMI, which was found only in single-level fusion group.

All ASD was found in listhesis grade I. This is different from the reported by Choon Sung Lee et al.⁽¹⁰⁾ that grades of listhesis did not affect ASD. To prove that listhesis grade I is a risk factor for single level fusion for treatment of degenerative L4 spondylolisthesis and multilevel lumbar stenosis need futher study and sufficient sample size. For BMI, increased BMI contributed to ASD,

especially BMI ≥ 25 kg/m, which was compatible with reported by Choon Sung Lee et al.⁽¹⁰⁾ Moreover, Hypolordotic alignment of L4-L5 resulted in the greatest amount of flexion-extension motion at L3-L4 whereas hyperlordotic alignment of L4-L5 resulted in the greatest amount of flexion-extension motion at L5-S1⁽²⁰⁾. This study found that lordosis angle after fusion are hypolordotic alignment and found cranial ASD in all 5 patients.

Limitations of this study including data regarding preexisting degeneratiion of adjacent disk, facet sagittalisation and facet tropism, especially for above fusion level which may be affected ASD, small case series, a short-term follow up for discovery ASD and the surgeon experience of the number of surgeries.

Conclusion

There is not significantly different in functional outcome between single levelor two level fusion with pedicular screws fixation in treatment of patients with degenerative L4 spondylolisthesis and multilevel lumbar stenosis. It cannot be concluded that two level fusion with pedicular screws fixation was effective for prevention ASD on cranial segment.

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Potential conflicts

None.

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ผลการผ่าตัดเชื่อมกระดูกสันหลังในโรคกระดูกสันหลังเคลื่อนระดับ L4: เปรียบเทียบการเชื่อมต่อกระดูก 1 ระดับ กับ 2 ระดับ

โชติ ภาวศุทธิกุล, พบ

วัตถุประสงค์: เพื่อศึกษาผลการรักษาผู้ป่วยโรคกระดูกสันหลังระดับเอวเคลื่อน (ระดับ L4) และมีช่องกระดูกสันหลังระดับเอวตีบ ตั้งแต่ระดับ L3-L5 ด้านการกลับไปใช้ชีวิต (*functional outcome*) และการเสื่อมของข้อกระดูกสันหลังระดับถัดขึ้นไป ด้วยวิธีผ่าตัดขยายช่องไขสันหลังและเชื่อมกระดูกสันหลังโดยใช้โลหะตาม เปรียบเทียบผลการผ่าตัดและการเชื่อมต่อกระดูก ระหว่าง 1 ระดับ กับ 2 ระดับ

วัสดุและวิธีการ: ศึกษาข้อมูลผู้ป่วยกระดูกสันหลังระดับเอวเคลื่อน (ระดับ L4) และมีช่องกระดูกสันหลังระดับเอวตีบ ตั้งแต่ระดับ L3-L5 ที่ได้รับการรักษาด้วยวิธีผ่าตัดขยายช่องไขสันหลังและเชื่อมต่อกระดูกสันหลังโดยใช้โลหะตาม 1 ระดับ (L4-L5) จำนวน 32 ราย ระหว่างปี พ.ศ.2550-2553 และด้วยวิธีผ่าตัดขยายช่องไขสันหลังและเชื่อมต่อกระดูกสันหลังโดยใช้โลหะตาม 2 ระดับ (L3-L4 และ L4-L5) จำนวน 35 ราย ในช่วงปี พ.ศ.2554-2556 โดยผู้ป่วยได้รับการติดตามการรักษาอย่างน้อย 5 ปี ประเมินผลการรักษาใช้แบบสอบถาม Oswestry Disability Index (ODI), คะแนนความเจ็บปวด visual analog pain scores (VAS) การเสื่อมของข้อกระดูกสันหลังระดับถัดขึ้นไป (*adjacent segment disease - ASD*) และการผ่าตัดเพื่อแก้ไขการเสื่อมของข้อกระดูกสันหลังระดับถัดขึ้นไป

ผลการศึกษา: ผู้ป่วยทั้งหมด 67 ราย อายุเฉลี่ย 55.76 ปี ได้รับการติดตามการรักษาเฉลี่ย 65.64 เดือน ค่าเฉลี่ยของคะแนน VAS และ ODI ดีขึ้นทั้งสองกลุ่มและไม่แตกต่างกันอย่างมีนัยสำคัญ แนวโค้งของกระดูกสันหลังส่วนเอว (*lordosis of lumbar*) หลังการผ่าตัดลดลงทั้งสองกลุ่ม และพบว่ามีการเปลี่ยนแปลงของมุม (*angulation*) การเคลื่อนของกระดูกสันหลัง (*translation*) และการลดลงของความสูงของหมอนรองกระดูก ในระดับสูงขึ้นไปทั้งสองกลุ่ม แต่ไม่มีความแตกต่างกันอย่างมีนัยสำคัญกลุ่มที่เชื่อมต่อกระดูก 1 ระดับ พบปัจจัยที่มีผลต่อการเกิด ASD ได้แก่ การเคลื่อนของกระดูกสันหลังก่อนผ่าตัด ระดับที่ 1 และค่าดัชนีมวลกาย (*BMI*) กลุ่มที่เชื่อมต่อกระดูก 2 ระดับ ไม่พบปัจจัยที่มีผลต่อการเกิด ASD สำหรับการเกิด ASD กลุ่มที่เชื่อมต่อกระดูก 1 ระดับ พบ ที่ระดับ L3-4 จำนวน 4 ราย (12.5%) กลุ่มที่เชื่อมต่อกระดูก 2 ระดับ พบ ASD ที่ระดับ L2-3 1 ราย (2.85%) การเกิด ASD ระหว่างสองกลุ่มไม่แตกต่างกันอย่างมีนัยสำคัญวิเคราะห์ข้อมูลด้วยสถิติเชิงพรรณนา โดยใช้ *Chi-square test* และ *student's t-test*

สรุป: ผลการรักษาผู้ป่วยกระดูกสันหลังระดับเอวเคลื่อน (ระดับ L4) ด้วยวิธีผ่าตัดขยายช่องไขสันหลังและเชื่อมกระดูกสันหลังโดยใช้โลหะตามระหว่าง 1 ระดับ กับ 2 ระดับ ไม่มีความแตกต่างกัน และไม่สามารถสรุปได้ว่าการเชื่อมต่อกระดูกสันหลังระดับเอว 2 ระดับ สามารถป้องกันการเสื่อมของข้อกระดูกสันหลังระดับถัดขึ้นไปได้

Estimation of Inter Iliac Crest Distance by Ulna Length Measurement for Reference in Reduction of Pelvic Fractures

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Objective: To determine inter iliac crest distance (IICD) by measurement of ulna length (UL) for reference in reduction of pelvic fractures (APC II).

Materials and Methods: A cross sectional study was done among 325 healthy participants. They were enrolled and stratified into two groups according to gender. UL and IICD of each participants were measured and recorded in centimeters. R-program was used for the statistical analysis. Pearson correlation was tested. Simple and Multiple linear regression model were estimated to predict dependent factors affecting IICD.

Results: The correlation between UL and IICD was 0.31 (P-value=0.001). The univariate equation was $IICD=13.66+0.57(UL)$, R^2 adjusted=0.10. The multivariate equation was $IICD=13.51+0.30(UL) + 0.08(BW) + 0.05(Age)$, R^2 adjusted=0.26, (BW=body weight).

Conclusion: This is the first estimation of IICD by measurement of UL for reference in reduction of pelvic fracture (APC II). Because of low correlation, using this numeric assessment should be cautiously applied in clinical practice.

Keywords: Pelvic fracture, Ulna length, Inter iliac crest distance, pelvic width

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Introduction

Pelvic fractures of different types were reported as 2-8 percent of all skeleton fractures⁽¹⁻³⁾. Anterior Posterior Compression type II (APC II) fractures, in particular, are characterized by the widening of pubic symphysis greater than 2.5 cm. caused by injuries to the anterior sacroiliac (SI) complex resulting in anterior SI widening while the posterior SI ligaments remain intact (open - book pelvic fractures), according to the Young-Burgess classification⁽⁴⁾. In any case of APC II fractures, both in trauma and pubic symphysis separation after delivery, anterior or posterior external fixations or pelvic circumferential compression devices were employed as an effective instrument to reduce the pelvic ring for achieving nearly anatomic reduction⁽⁵⁻¹¹⁾.

Nonetheless, in clinical practices, physicians performing anterior or posterior external fixation or using other devices simply estimate the width of pubic symphysis after the initial radiographic evaluation. It's inadequate evidence for reduction of pelvic fractures. No numeric data available for assessment the width of reduction. Only clinical experience may induce under or over reduction. Under or over reduction of pelvis would

induce inappropriate tamponade effect. Lack of study reported the accuracy of reduction under a simple estimation method. Moreover, the accuracy of pelvis length reduction currently depend on clinician's experience rather than evidence based estimation. The estimation was made by the physicians' experiences of manual feeling and made personal judgment in reducing the pelvic ring to nearly anatomic reduction in the patient who remained haemodynamically unstable and required reducing pelvic volume in open-book pelvic fractures, but numeric assessment for performing to estimate the width of pelvic ring found only one study by use of the foot length⁽¹²⁾.

In Anthropology, studies were conducted on the estimation human stature or height by measurement of ulna length⁽¹³⁻¹⁷⁾. Other studies and forensic anthropology were also performed to determine age, sex, and body size⁽¹⁸⁻²⁰⁾. Ulna bone is a subcutaneous bone. It is easy to palpate and measure compare with other bony landmarks. Moreover, it has been used to determine age, sex, and stature in previous studies. However, previous studies never demonstrated any relationship with pelvic length.

No previous studies, however, showed relationship of ulna length (UL) and the inter iliac crest distance (IICD). The present study was an attempt to estimate the relationship of ulna length and the inter iliac crest distance for the accuracy in reducing the pelvic ring in cases of pubic

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symphysis separation (APC II) in clinical application. It was expected to be used for estimation in reducing of pelvic fracture, especially in APC II of trauma.

Materials and Methods

Study design: A cross-sectional study.

Sample size calculation

The formula for estimating a correlation was used to calculate the sample size. The alpha and beta was 0.05 and 0.20 respectively. Estimated correlation coefficient was 0.166 (from the pilot study). Consequently the sample size were 283. Then 15% of non-response rate were calculated, the total sample size were 325.

Participants

The inclusion criteria included healthy people aged equal to or greater than 20 years. The exclusion criteria were 1) previous history of pelvic or forearm fractures, 2) systemic metabolic bone diseases, 3) anomaly or deformity of stature or limb. 325 healthy people in south of Thailand who 20-88 years old were voluntary enrolled in the study in the year 2016. They were stratified into 2 groups according to gender. All subjects had no history of trauma. Because the pubic symphysis separation during pregnancy and delivery may be difference among women, female participants were divided into three subgroups; single, married without children, and married with children. On the other hand, because of no differences in pelvic width, male participants were put into only one group.

Data collection

Data collection, completed within three months, was performed in a room specifically arranged in the participating hospital. The IICD, the most widest diameters between two iliac crest points in upper part of iliac crest, was measured manually using a caliber in undress supine position as shown in figure 1. Similarly, the ulna (right side) length of each subject was measured from the ulna styloid process to the tip of olecranon in supine position using a measuring tape. All measuring data were recorded in centimeters with one decimal point. The body weight, however, was recorded in kilograms with one decimal point. Each manual measuring process for IICD and UL were measured twice by 2 separated well-trained nurses. A pilot study was developed and tested on 20 participants (10 males, 10 females). Inter-observer reliability of UL and IICD measurement was 0.93 and 0.89 respectively. The correlation coefficient was 0.166.

Statistical analysis

R-program was used for data analysis. Median and interquartile range (IQR) were used for describing characteristics of participants. Pearson correlation was tested for linear relationship. Simple and multiple regression model (Method: backward stepwise) were used to determine the dependent factors that predict IICD.

Ethical consideration

This study was approved by the Research Ethics Committee of Hatyai Hospital (REC-HY). Protocol number 20/2529.

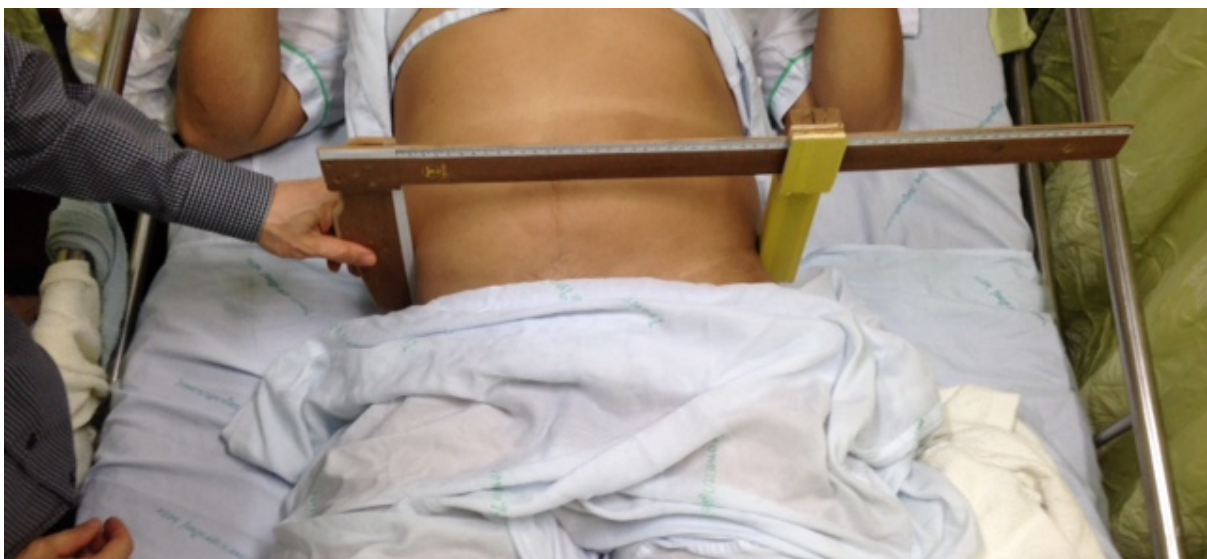


Fig. 1 Demonstrating the IICD measurement

Results

Table 1 Participants' characteristic

	Male, n = 161 Median (IQR)*	Female, n = 164 Median (IQR)*
UL (cm)	27.0 (26.0,28.0)	25.0 (24.0,25.5)
IICD (cm)	28.2 (27.0,32.0)	27.5 (25.7,29.0)
Height (cm)	167 (163,172)	157 (153,160)
Body weight (kg)	64.0 (57,72)	55.0 (50,64)
Age (year)	47.0 (37,55)	39.0 (28,51)

*IQR = Interquartile range 25 percentile and 75 percentile

Table 2 Associations between UL and IICD using univariate analysis

<i>P</i> -value	Constant	Crude Coefficient	95% CI
UL < 0.001	13.66	0.57	0.38, 0.76
BW < 0.001	21.96	0.10	0.08, 0.13
Age < 0.001	25.78	0.06	0.04, 0.08
Height < 0.001	11.18	0.11	0.07, 0.14
Female gender < 0.001	29.17	-1.68	-2.32, -1.04

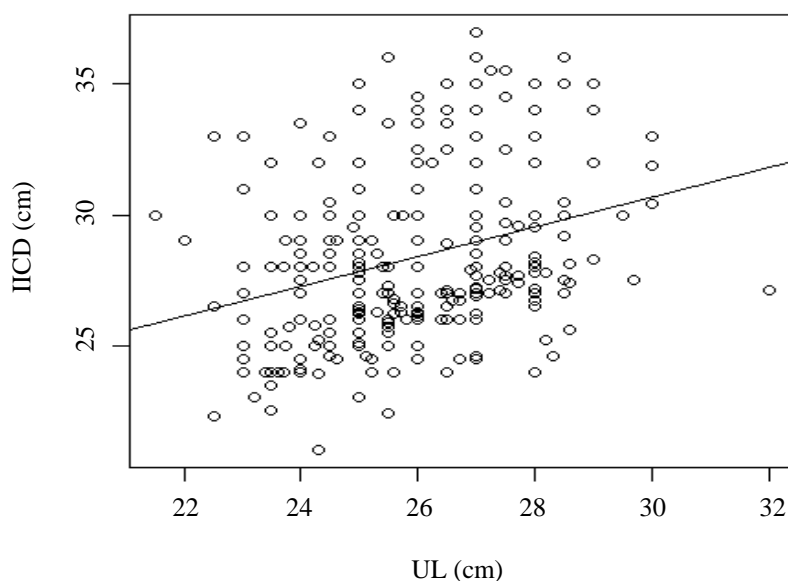


Fig. 2 The correlation between UL and IICD

Table 3 Associations between UL and IICD using backward multivariate stepwise regression analysis

<i>P</i> -value	Constant	Adjusted coefficient	95% CI
UL 0.001	13.51	0.30	0.12, 0.49
BW < 0.001	13.51	0.08	0.06, 0.11
Age < 0.001	13.51	0.05	0.03, 0.07

There were 325 participants; 161 male (49.54%), 164 female (50.46%). Among female, there were three subgroups of marital status; 55 single, 18 married with no children, 91 married with children, the range of IICD were 22.0-30.5 cm, 22.3-30.0 cm, and 22.5-34.0 cm respectively. There was no significant difference of IICD among these three subgroups. Other characteristics were shown in table 1. The correlation between UL and IICD was 0.31 (P -value = 0.001) as shown in figure 2.

Univariate analysis

There was a significant linear relationship between UL and IICD (crude coefficient 0.57, 95% CI 0.36, 0.76, P -value < 0.001). The univariate equation was

$$\text{IICD} = 13.66 + 0.57(\text{UL})$$

$$R^2 \text{ adjusted} = 0.10$$

(IICD = inter iliac crest distance,
UL = ulna length)

The covariate factors such as body weight, age, and height were significantly found associated with IICD (P < 0.001). Being female was more likely to have lower IICD (crude coefficient -1.68, 95% CI -2.32, -1.04, P -value < 0.001).

Multivariate analysis

The backward stepwise regression model was used to estimate an association between UL and IICD. The final model included only body weight and age. There was a significant linear relationship between UL and IICD after adjusted for body weight and age (adjusted coefficient 0.30, 95% CI 0.12, 0.49, P -value < 0.001) The multiple variate equation was

$$\text{IICD} = 13.51 + 0.30(\text{UL}) + 0.08(\text{BW}) + 0.05(\text{Age})$$

$$R^2 \text{ adjusted} = 0.26$$

(IICD = inter iliac crest distance,
UL = ulnar length, BW = body weight)

Discussion

Previous studies have used ulna length to estimate human stature or height, sex and body size. There were close correlation between ulna length and those factors. A good correlation of stature was observed with UL and it was statistically highly significant⁽¹³⁾, sex determination accuracy as high as 96%⁽¹⁸⁾. Present study found significant low correlation between ulnar and pelvic length.

The present study found that males' ulna length and inter iliac crest distance were longer and

wider than females. The reasons could be because of male's anatomy which males usually taller than females. The negatively linear correlation between UL and IICD was found among females gender compared with male. There was no significant difference of IICD among females who were single, married with no children, and married with children. In backward stepwise multivariate analysis, it was found that height was not significantly associated with IICD. The variables effect to predict IICD were body weight and age. Although the coefficient was not so high when compared with ulna length. To predict IICD by UL, the authors found that UL could predict IICD precisely after adjusted for body weight and age. Previous study used foot length to relate the inter anterior superior iliac distance⁽¹²⁾. Nevertheless, in clinical practice, inter anterior superior iliac distance has found difficult to measure compare with inter iliac crest distance. Thus, pelvic length was more preferable than inter anterior superior iliac distance. In clinical observation, ulnar length, which easy to palpate and measure, was observed to have relationship with pelvic length.

However, since the correlation coefficient between UL and IICD was low at 0.31 and R^2 adjusted in multiple variate equation was low at 0.26, aware of using UL for IICD estimation should be concerned. Clinical judgment using simple clinical estimation combine with numeric estimation from the equation would be the solution for applying in clinical practice. The result from larger size of study may be needed for more precise. Also other organs will be found to be more accurate reference for IICD estimation in reduction of pelvic fractures.

Conclusion

This is the first estimation of IICD by measurement of UL for reference in reduction of pelvic fracture (APC II). Because of low correlation, using this numeric assessment should be cautiously applied in clinical practice.

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What is already known on this topic?

Measurement of ulna length could be performed to determine human stature or height, age, and sex.

What this study adds?

This study is the first study to estimate inter iliac crest distance by measurement of ulna length for reduction pelvic fractures.

Potential conflicts of interest

None.

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การประเมินความกว้างของกระดูกเชิงกรานโดยใช้ความยาวของกระดูก *ulna* เป็นตัวอ้างอิงในการจัดกระดูก เชิงกรานที่หัก

ศตพงษ์ พิสุทธิธรรมาภรณ์, พบ, จุก สุวรรณโณ, พว, ภัทราวรณ ทองตาล่วง, พว

วัตถุประสงค์: เพื่อหาความสัมพันธ์ระหว่างความยาวของกระดูก *ulna* (UL) และความกว้างของกระดูกเชิงกราน (IICD)

วัสดุและวิธีการ: กลุ่มตัวอย่าง 325 คน แบ่งเป็นชาย 161 คน หญิง 164 คน วัดความยาวของกระดูก *ulna* (จาก *ulna styloid process* ถึงปลายของ *olecranon*) และความกว้างของกระดูกเชิงกราน (ส่วนที่กว้างที่สุดของขอบนอกของ *iliac crest*) วิเคราะห์หาความสัมพันธ์โดยใช้ *Pearson correlation test* และใช้ *multiple* กับ *simple linear regression model* เพื่อหาอิทธิพลของตัวแปรที่มีผลต่อการทำนายความกว้างของกระดูกเชิงกราน

ผลการศึกษา: ความสัมพันธ์ระหว่างความยาวของกระดูก *ulna* และความกว้างของกระดูกเชิงกราน = 0.31 ($P\text{-value}=0.001$) สูตรการทำนายความกว้างของกระดูกเชิงกราน โดยใช้การวิเคราะห์แบบ *univariate* คือ $IICD = 13.66 + 0.57(UL)$, $R^2\text{ adjusted} = 0.10$ ส่วนการวิเคราะห์แบบ *multivariate* สูตรที่ได้คือ $IICD = 13.51 + 0.30(UL) + 0.08(BW) + 0.05(Age)$, $R^2\text{ adjusted} = 0.26$, ($BW = \text{body weight}$)

สรุป: เป็นการศึกษาครั้งแรกที่ใช้ความยาวของกระดูก *ulna* เป็นตัวอ้างอิง ในการทำนายความกว้างของกระดูกเชิงกราน เพื่อจัดกระดูกเชิงกรานหักแบบ *APC II* แต่มีความสัมพันธ์ต่ำ ควรใช้ด้วยความระมัดระวังในทางปฏิบัติ

Severe Genu Recurvatum Deformity Treated with Primary Rotating Hinge Replacement: A report of 2 cases

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Introduction: Osteoarthritis in severe genu recurvatum associated with quadriceps weakness is one of the most challenging problems in total knee arthroplasty. The recurrent recurvatum deformity after knee replacement can be prevented by using rotating hinge knee prosthesis (RHK). However, the implant survivorship and performance of knee function after surgery are not well documented.

Materials and Methods: We reported the early clinical and radiographic outcomes of end-stage severe genu recurvatum arthritis associated with quadriceps weakness treated with RHK in 2 patients. The initial hyperextension deformity were 35 and 42 degrees measured from sagittal weight bearing radiograph. The follow-up time was 18 months.

Results: Quadriceps muscle strength at the last follow up were 36% and 126% above the preoperative baseline. Modified Time Up and Go test was improved from 31.06 to 18.26 seconds at 18 months follow-up in one patient. Both patients showed significant improvement in WOMAC knee score and Knee Society Score at the last follow-up. There were neither radiographic signs of implant loosening nor recurrent deformity in both patients.

Conclusion: The quadriceps muscle strength can be improved even in preexisting neuromuscular disorder. Primary RHK can be used as salvage procedure for severe genu recurvatum arthritis with quadriceps weakness from neuromuscular disorder.

Key words: Total knee replacement, motor weakness, Genu recurvatum, Quadriceps recovery, Rotating hinge prosthesis, result

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Introduction

Degenerative osteoarthritis with genu recurvatum deformity is a challenging problem for reconstruction with total knee replacement (TKR). The most common surgical problem is the recurrent recurvatum deformity^(1,2). Previous literatures have been show that patients with post-operative recurvatum deformity following TKR have significantly poorer functional result^(3,4). Normally, osteoarthritis with mild degree of genu recurvatum deformity can be managed with conventional implant by using a surgical technique described by Petterson and Insall⁽²⁾. It has been recognized that the rate of recurrent genu recurvatum after TKR was 3.7% in patients without neuromuscular disorder⁽⁵⁾. However, the incidence of recurrence genu recurvatum following conventional or constrained condylar knee implant (CCK) TKR, could be high as 50% in quadriceps-weakness patients^(6,7). Moreover, the patient with recurrent

recurvatum deformity usually reported dissatisfaction and disability. To prevent this problem, rotating hinge knee prosthesis (RHK) is one of the promising implant designs. The extension stopper design in RHK prosthesis prevents post-operative recurrence of the deformity and eliminates unbalance flexion-extension gap. However, controversy exists over the use of RHK prosthesis in primary surgery with regard to implant survival and complexity of future revision. However, the new RHK design shows good to excellent mid-term results as reported by Petrou et al⁽⁸⁾ and Barrack⁽⁹⁾. The new RHK is designed to reduce force transmitted to the fixation interface, so it improves the implant survival. As the longer implant survival has been proved, RHK should be the more suitable implant to prevent recurrent genu recurvatum after TKR especially in severe recurvatum associated with neuromuscular disorder patients.

To our knowledge, only few literatures have reported the use of primary RHK in genu-recurvatum deformity associated with quadriceps-weakness patients^(6,10). Most studies only focused on survival of the implant and the recurrent

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recurvatum deformity rate without information on the patient performance after surgery. We have herein reported the objective performance knee function in term of quadriceps strength recovery, modified time up to go test and the functional knee score in patients with quadriceps-weakness, severe genu-recurvatum deformity who are receiving primary RHK.

Materials and Methods

Between 2013 and 2015, 2 primary RHKs were performed in lower extremity weakness patients affected by end-stage genu recurvatum arthritis by an experienced adult reconstruction surgeon at our institution. The selection criteria were failed-conservative- treatment osteoarthritis patients with pain and difficult ambulation, genu recurvatum with quadriceps weakness at least grade 3 according to Medical Research Council (MRC) scale for muscle strength⁽¹⁾. Decision for the use of RHK was made preoperatively according to physical examination, risk of post-operative recurrent genu recurvatum deformity (RRD), future complication and patient expectation. The visual analog pain scale (VAS), quadriceps muscle strength (QP), Modified time up and go test (TUGT), Knee Society score (KSS), and WOMAC knee score were recorded pre and post-operatively. Radiographic signs of implant loosening were collected pre-operatively and post-operatively. QP was measured by using peak-force hand held dynamometer device (Microfet2, Hoggan Health industries, USA), applied at just above the ankle in knee flexion 40-50 degrees and asked patient to extend their knee against examiner. TUGT was the time spending from sit, chair-raise and walk straight forward for 3 meters.

All knees were operated using medial parapatellar approach after tourniquet was fitted at 350 mmHg. Bone work was done using measure resection technique. We used a technique described by Peterson and Insall⁽²⁾ which was decreasing amount of distal femoral cut and decreasing femoral anterior-posterior size to balance extension and flexion gap as much as possible. The proximal tibia was prepared by using intra-medullary guide. Proximal tibial was cut perpendicularly to the tibial axis in coronal plane. In sagittal plane, there was no tibial slope as recommended for Nex Gen RHK design. The patella was resurfaced. Peri-articular cocktails (0.5% bupivacaine 20 ml, ketorolac 30 mg, cefuroxime 750 mg, tranexamic acid 250mg) was injected before implanting the prosthesis. All patients were operated by using Nex Gen RHK (Zimmer®, Warsaw, Ind, USA) prosthesis. PMMA bone cement (Palacos®, Heraeus, Wehrheim, Germany) was used at the back-side of femoral and tibial components, but not for the stems. All patients were operated under regional anesthesia.

Suction drain was applied and 500 mg of Tranexamic acid was injected intra-articularly through the drain. Suction drain was clamped for 2 hours and removed within 48 hours after surgery. We encouraged patients to start full weight bearing ambulation with walker at second post-operative day. Discontinuation of walker and switch to single cane was encouraged by 6 weeks. All patients were followed up regularly until 12 month, with radiographic assessment at 6 months and then yearly. The radiographic signs of implant migration and loosening were recorded.

Patients and results

Case 1

A seventy-five-year-old woman came in to the clinic with disabling pain and walking difficulty. Twenty-years ago, she was diagnosed with a brain tumor and underwent craniotomy with tumor removal. After brain surgery, she experienced right lower limb weakness and her right knee was gradually deformed (figure1). The physical examination showed grade 3 muscle strength at right hip and knee both flexion and extension, according to MRC scale. Right ankle dorsiflexion and plantar flexion strength were grade 0. Range of motion at right knee was, measured by goniometer, 140 degrees flexion and 42 degrees hyperextension. She was scheduled for total knee replacement with RHK prosthesis. Pre-operative and post-operative data were shown in table 1. Pre-operative clinical and radiographic evaluations were shown in figure1. Concerning post-operative period, we encourage patient to perform self-quadriceps exercise as much as possible. We allow patient to ambulate full weight bearing without brace from the second post-operative day. The gait assistance device was discard as soon as possible.

There was no hyperextension deformity on the physical examination at 18 month follow-up. Regard the post-operative radiograph, there was slightly non-progressive knee hyperextension on the radiograph taken at first operative day and the 18 months follow-up. Our patient reported significant improvement of pain on weight bearing since the second week and no pain during weight bearing until the last follow up. This directly correlated with a gradual improvement in WOMAC and KSS scores during the follow-up period. As knee stability increased, this patient reported improvement in chair-raise, stair-climbing and walking ability. This result was seen in 41% faster TUGT at 18 month compared with the pre-operative level. Considering the QP, muscle strength recovered to baseline by 3 months and increased by 36% from baseline at 18 months. There were no radiographic and clinical signs of implant loosening at 1 year (figure2).

Case 2

A seventy-seven-year-old man had suffered from poliomyelitis since he was 3 years old. He complained of pain and genu recurvatum deformity on his left lower extremity. Physical examination shows hip muscle strength grade 5, knee extension grade 3 muscular weakness according to MRC scale. Ankle dorsiflexion and plantar flexion were grade 0. The preoperative knee range of motion was 150 degrees flexion and 35 degrees hyperextension without extension lag. Initial radiograph showed arthritic changes with severe hyperextension (figure 3). The pre-operative and post-operative data has been summarized in table 1. He was scheduled for total knee

replacement using RHK prosthesis according to the previously described criteria.

There was no genu recurvatum deformity on the physical examination at the last follow-up. Pain was significantly reduced. There was only mild pain during a long distance walk. WOMAC and KSS scores were improved. Quadriceps muscle strength was 126% improved from baseline. The postoperative radiograph was taken at 18 months (figure 4). There was a non-progressive sclerotic line around the tip of femoral stem without signs of implant migration. Neither radiolucency line between bone-cement nor cement-prosthesis interface were observed.

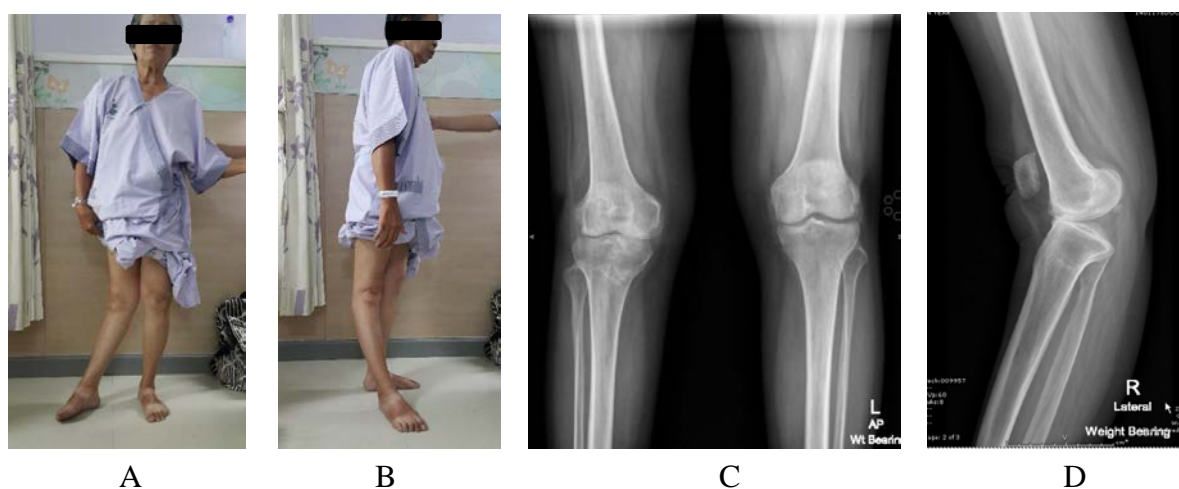


Fig. 1 Pre-operative clinical and radiographic evaluation. Picture on left (A, B) show genu valgus and recurvatum deformity. Plain radiograph on the right (C, D) show arthritis change with 42 degrees recurvatum deformity.

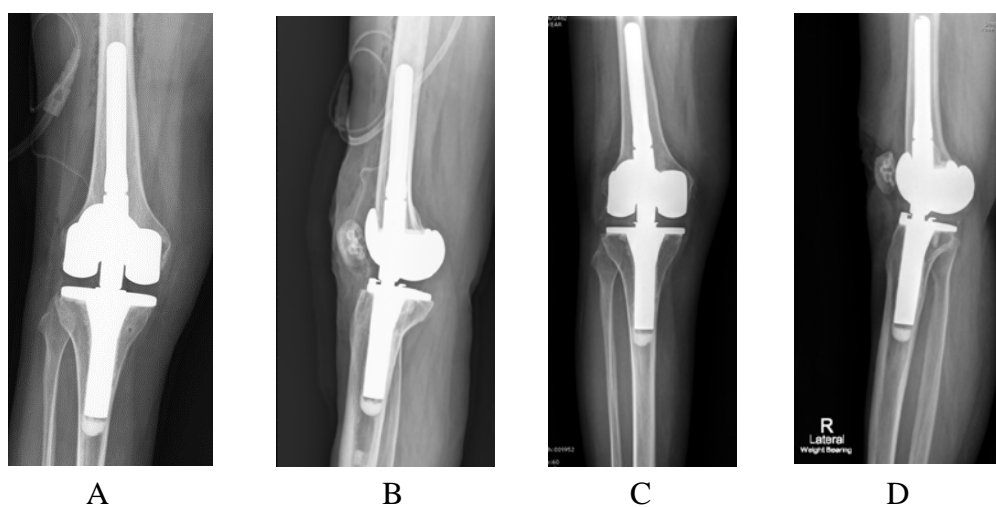


Fig.2 A, B show the immediate post-operative film and C, D were the x-ray at 1 year follow-up. There were neither implant migration nor abnormal radiolucency line between bone-cement and cement-prosthesis interface.



Fig.3 Preoperative radiographic evaluation. There was an arthritis change in both views with 35 degrees hyperextension deformity.

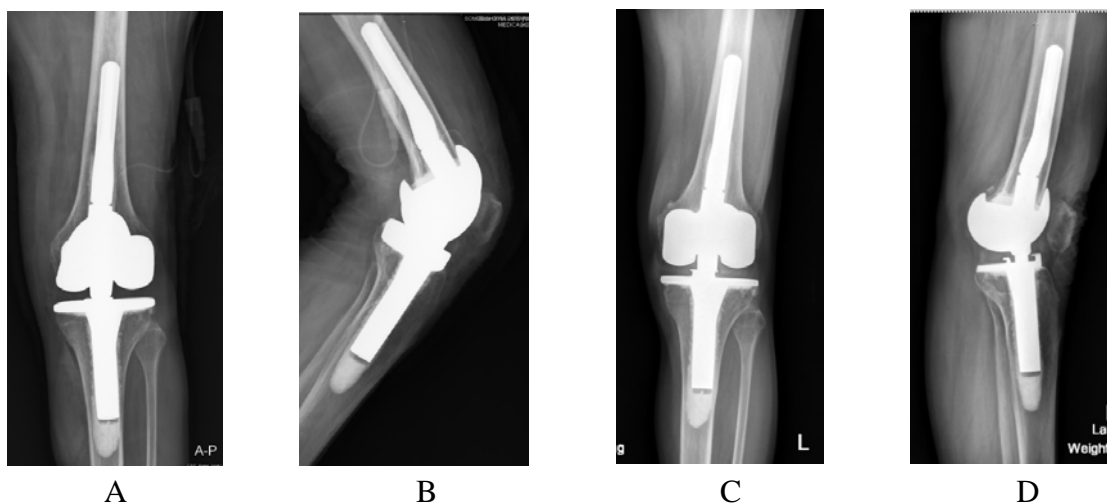


Fig. 4 A, B show the immediate post-operative x-ray and C, D were the 18-month radiographic evaluation. There was a non-progressive sclerotic line at tip of femoral stem. Neither implant malposition nor abnormal radiolucency line between cement-prosthesis interface were observed.

Table1 Summary of the preoperative and postoperative data of 2 patients. : NA, not available

	Case 1	Case 2
Flexion arch (degrees)		
- Pre-operative	140	150
- 3 months	120	NA
- 6 months	116	NA
- 18 months	123	124
Hyperextension (Degrees)		
- Pre-operative	42	35
- 3 months	0	NA
- 6 months	0	NA
- 18 months	0	0
VAS during walking		
- Pre-operative	7	5
- 3 months	0	NA
- 6 months	0	NA
- 18 months	0	0

	Case 1	Case 2
QP (Newton)		
- Pre-operative	74	30
- 3 months	80	NA
- 6 months	68	NA
- 18 months	101	68
TUGT (sec)		
- Pre-operative	31.06	NA
- 18 months	18.26	NA
WOMAC		
- Pre-operative	92	49
- 3 months	57	NA
- 6 months	56	NA
- 18 months	54	31
KSS		
- Pre-operative	75	85
- 3 months	144	NA
- 6 months	149	NA
- 18 months	164	170

Discussion

Total knee replacement (TKR) in genu recurvatum patients is usually problematic among arthroplasty surgeons, especially in patients who have muscular weakness. Arthrodesis is not the recommended procedure in this situation since this procedure restricts knee motion and causes difficulty in climbing up and down stairs⁽¹²⁾. To achieve the goal of treatment of end stage osteoarthritis which are pain relief and restored knee function, TKR is the more appropriate option than arthrodesis.

Recurrent recurvatum deformity (RRD) following TKR is the most controversial topic as this deformity diminishes knee sagittal stability, causes unwelcome pain and decreases patient satisfaction. Koo et al⁽³⁾, reported significantly poorer functional knee score in patients with mean recurvatum of -3.94 degrees compared with mean flexion contracture 5.78 degrees at 2 years following TKR. Patients with recurvatum at 6 months after TKR, had 6.5 times higher risk of deformity progression compared with those without recurvatum at 6 months⁽⁴⁾. Meticulous balance of the flexion-extension gap is crucial. It is necessary to make the extension gap a bit smaller than the flexion gap to prevent recurrent deformity when conventional implant is used. However, in severe recurvatum associated with lower extremity weakness, those problems could not be addressed with the conventional implant. The incidence of RRD has been proposed by Meding et al⁽⁵⁾. They reported 2 out of 53 patient had RRD and did not require revision surgery. However in the study group of Meding, no patients had muscular weakness. Theoretically, in quadriceps weakness patients, the incidence of RRD could be much higher than the patient with genu-recurvatum with

only ligament laxity and greater chance of deformity progression. Costanzo and Pancino⁽¹³⁾ described that patients with quadriceps weakness lose their ability to lock the knee during the load bearing phase of the step. They compensate this phenomenon by passively moving gravity line in front of the articular axis of the knee during stance phase which results in genu recurvatum deformity. This theory was supported by up to 50% RRD rate in neuromuscular disorder patients with osteoarthritis treated with conventional TKA implant as reported by Tigani et al⁽⁶⁾, and Giori and Lewallen⁽⁷⁾. For those reasons, rotating hinge knee (RHK) prosthesis is a more appropriate implant to prevent RRD in these patients. Extension stopper and hinge connect between femoral-tibial components eliminate the risk of post-operative hyperextension deformity and it is easier to balance extension-flexion gap. However, concern has been expressed over the use of constrained implant in primary TKR due to increase in load transfer to the fixation interface and consequently loosen the implant. Considering that, the modern rotating hinge design allows better distribution of shearing force and reduces amount of force interaction at hinge mechanism by transferring 95% of compression force through the articular contact between femoral condyle and tibia articular surface rather to the hinge mechanism alone^(14,9). We believed the survival rate of new RHK design could be longer than expected and could be used in quadriceps weakness patients.

Our study demonstrated an improvement in pain, functional score, and TUGT in both patients. There was no radiographic sign of implant loosening at 18 month follow up. Survival of RHK has been reported in several studies. Barrack⁽⁹⁾ reported non implant loosening in modern RHK

during 2-9 years follow-up. On the contrary, Martin et al⁽¹⁵⁾ who have demonstrated decrease in survival free rate of all-cause reoperation at 10 years with hazard ratio of 2.07 for RHK compared with unconstrained implant. The implant overall revision-free survival rates for RHK were 74.6% at 10 years. However, the most common cause of re-operation were wound complication, infection and stiffness, not implant loosening.

In the majority of patients following TKR, quadriceps strength will recover on average to preoperative baseline within 6 months⁽¹⁶⁾. This also included the patients with neuromuscular disorder as our data showed that quadriceps strength returned to baseline at 3 months after surgery. Surprisingly, both patients showed 36% and 126% quadriceps strength improvement at the last follow-up. Therefore, even a patient with preexisting neuromuscular disorder still has a chance to improve muscle strength postoperatively. Encouraging postoperative muscle strengthening exercise is imperative as higher quadriceps muscle strength leads to better knee function⁽¹⁷⁾.

There are some limitations in this study. First this is the retrospective case report of only 2 patients and second, the results reported in this study was only 18 months after treatment with RHK prosthesis. Therefore, our study did not reflect mid-term and long-term result of genu recurvatum knee associated with neuromuscular disorder who were treated with RHK prosthesis.

Conclusion

Severe genu recurvatum deformity associated with neuromuscular disorder can be treated by primary RHK prosthesis with favorable result in terms of pain elimination and functional improvement. There were no implant loosening at 18 month follow-up. However, patient selection is essential, and we recommend primary RHK prosthesis in patients older than 70 year-old to reduce the chance of re-operation.

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กรณีศึกษาผลการรักษาในผู้ป่วย 2 รายที่มีภาวะข้อเข่าเสื่อมชนิดแอนทาทางด้านหน้ารุนแรงจากกล้ามเนื้อต้นขาอ่อนแรงด้วยการเปลี่ยนข้อเข่าเทียมชนิด *Rotating hinge*

กุลพัชร จุลสำลี, พบ, นรเทพ กุลโชติ, พบ, ศิวดล วงษ์ศักดิ์, พบ, พงศธร ฉันท์พลากร, พบ, ปพน สง่าสูงส่ง, พบ, ชาญยุทธ ศุภชาติวงศ์, พบ, วิโรจน์ กวินวงศ์โกวิท, พบ

กรณีศึกษาได้แสดงถึงผลการรักษาภาวะข้อเข่าเสื่อมชนิดแอนทาทางด้านหน้าในผู้ป่วยที่มีโรคกล้ามเนื้อต้นขาอ่อนแรงด้วยการเปลี่ยนข้อเข่าเทียมชนิด *Rotating hinge* การรักษาด้วยการใช้ข้อเข่าเทียมชนิด *Rotating hinge* จะช่วยลดโอกาสการเกิดเข่าแอนทาทางด้านหน้าซ้ำภายหลังการผ่าตัด ซึ่งมักจะเกิดได้บ่อยหากใช้ข้อเข่าเทียมชนิดปกติ (*conventional implant*) การศึกษารูปแบบแอนทาทางด้านหน้าภายหลังการผ่าตัดเปลี่ยนข้อเข่าจะทำให้ผู้ป่วยมีอาการปวด ใช้ชีวิตประจำวันลำบาก ซึ่งบางกรณีนำไปสู่การผ่าตัดเปลี่ยนข้อเข่าเทียมครั้งที่สอง (*Revision total knee replacement*) อย่างไรก็ตามการใช้ข้อเข่าเทียมชนิด *Rotating hinge* ในทางทฤษฎีอาจทำให้เกิดภาวะข้อเข่าเทียมหลวม (*loosening*) ได้เร็วกว่าปกติ ปัจจุบันการรายงานผลการรักษาภาวะดังกล่าวด้วยข้อเข่าเทียมชนิด *Rotating hinge* น้อย เนื่องจากภาวะดังกล่าวพบได้ไม่บ่อย

การศึกษานี้ได้รายงานผลการรักษาผู้ป่วยที่มีการผิดปกติของข้อเข่าแบบแอนทาทางด้านหน้ารุนแรงร่วมกับมีโรคกล้ามเนื้อต้นขาอ่อนแรง และรับการผ่าตัดด้วยการเปลี่ยนข้อเข่าเทียมชนิด *Rotating hinge* จำนวน 2 ราย ที่ระยะ 18 เดือน คณะผู้ศึกษาไม่พบว่ามีอาการหลวมของข้อเข่าเทียมจากภาพรังสี และไม่พบการผิดปกติซ้ำในผู้ป่วยทั้ง 2 ราย นอกจากนี้พบว่าผู้ป่วยทั้งสองรายมีกำลังกล้ามเนื้อต้นขา *quadriceps* ที่มากขึ้นร้อยละ 36 และ 126 เมื่อเปรียบเทียบกับก่อนการผ่าตัด ซึ่งบ่งชี้ว่าการใช้ *Rotating hinge* รักษาผู้ป่วยภาวะดังกล่าวสามารถป้องกันการผิดปกติซ้ำ นอกจากนี้ยังสามารถช่วยฟื้นฟูสมรรถภาพของกล้ามเนื้อต้นขาภายหลังการผ่าตัดได้เป็นอย่างดี

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Please use no more than three levels of displayed headings.

Abbreviations

Abbreviations should be defined at first mention and used consistently thereafter.

Footnotes

Footnotes on the title page are not given reference symbols. Footnotes to the text are numbered consecutively; those to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data).

Acknowledgements

Acknowledgements of people, grants, funds, etc. should be placed in a separate section before the reference list. The names of funding organizations should be written in full.

Tables

- All tables are to be numbered using Arabic numerals.
- Tables should always be cited in text in consecutive numerical order.
- For each table, please supply a table heading. The table title should explain clearly and concisely the components of the table.
- Identify any previously published material by giving the original source in the form of a reference at the end of the table heading.
- Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data) and included beneath the table body.

Figures

Electronic Figure Submission

- Supply all figures electronically.
- Indicate what graphics program was used to create the artwork.
- For vector graphics, the preferred format is EPS; for halftones, please use TIFF format. MS Office files are also acceptable.
- Vector graphics containing fonts must have the fonts embedded in the files. Name your figure files with "Fig" and the figure number, e.g., Fig1.eps.

References: List the references in consecutive, numerical order, as they are cited in the text. Use the Vancouver style. If the list of authors exceeds 6, the first 6 authors followed by et al should be listed for those references. Abbreviate journal titles according to the style used in the Index Medicus. See also http://www.medscape.com/home/search/indexMedicus/Index_Medicus-A.html

Example of references:**Journal articles.**

1. You CH, Lee KY, Chey RY, Menguy R. Electrogastrographic study of patient with unexplained nausea, bloating and vomiting. *Gastroenterol* 1980;79:311-4.
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1. Wettstein A, Dore G, Murphy C, Hing M, Edward P. HIV-related cholangiopathy in Australia. IX Annual Conference of the Australasian Society of HIV Medicine. Adelaide, November 1997 [abstract P45].
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1. Getzen TE. *Health economics: Fundamentals of funds.* New York: John Wiley & Sons; 1997.
2. Porter RJ, Meldrum BS. Antiepileptic drugs. In: Katzung BG, editor. *Basic and clinical pharmacology.* 6th ed. Norwalk: Appleton & Lange; 1995. p.361-80.

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1. Morse SS. Factors in the emergence of infectious disease. *Emerg Infect Dis* [serial online] 1995 Jan-Mar;1(1):[24 screens]. Available from: URL:<http://www/cdc/gov/ncidoc/EID/eid.htm>. Accessed December 25,1999.
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คำแนะนำสำหรับผู้ส่งบทความเพื่อลงตีพิมพ์

จุดมุ่งหมายและขอบเขต

วารสาร The Thai Journal of Orthopaedic Surgery เป็นวารสารทางวิชาการของราชวิทยาลัยแพทย์ออร์โธปิดิกส์แห่งประเทศไทยที่พิมพ์เผยแพร่อย่างสม่ำเสมอทุก 3 เดือน (4 ฉบับ/ปี) ทั้งแบบเป็นเอกสารรูปเล่ม และแบบออนไลน์ โดยเป็นวารสารที่ได้รับการประเมินบทความโดยผู้ทรงคุณวุฒิ (peer-reviewed journal) เพื่อเปิดโอกาสให้นักวิชาการที่สนใจเสนอบทความที่เกี่ยวข้องกับการรักษาผู้ป่วยและผลงานวิจัยทางศัลยศาสตร์ออร์โธปิดิกส์

เพื่อรักษามาตรฐานของวารสาร บทความที่จะลงตีพิมพ์ในวารสารจำเป็นต้องเขียนเป็นภาษาอังกฤษ ซึ่งประกอบด้วย Original Articles, Case Report, Review Articles, Letter to the Editor และ Miscellany

บทความประเภท Original articles เป็นรายงานผลการวิจัยทางด้านศัลยศาสตร์ออร์โธปิดิกส์ และสาขาอื่นที่เกี่ยวข้อง

บทความ Review articles เป็นบทความที่รวบรวมเอาผลงานในเรื่องใดเรื่องหนึ่งโดยเฉพาะ ซึ่งเคยลงตีพิมพ์มาแล้วนำมาวิเคราะห์ วิเคราะห์ เพื่อให้เกิดความกระจ่างในเรื่องนั้นยิ่งขึ้น

รายงานผู้ป่วย (Case report) เป็นรายงานผู้ป่วย วิเคราะห์อาการทางคลินิกและผลตรวจทางห้องปฏิบัติการที่น่าสนใจ เรื่องที่ส่งมาต้องไม่เคยพิมพ์เผยแพร่มาก่อน กองบรรณาธิการขอสงวนสิทธิ์ในการตรวจทาน แก้ไขต้นฉบับ และพิจารณาตีพิมพ์ข้อคิดเห็นในบทความเป็นความเห็นและเป็นความรับผิดชอบของเจ้าของบทความโดยตรง

การส่งบทความ

ทางราชวิทยาลัยฯ ขอแจ้งให้ทราบว่า เพื่อความสะดวกรวดเร็วและมีประสิทธิภาพในการส่งบทความ ราชวิทยาลัยฯ ผู้เขียนสามารถเสนอบทความเพื่อพิจารณาได้ทางจดหมายอิเล็กทรอนิกส์ secretariat@rcost.or.th

ประเภทของบทความ

- นิพนธ์ต้นฉบับ (original articles) ให้มีความยาวไม่เกิน 5,000 คำ, เอกสารอ้างอิงไม่เกิน 40 ข้อ, รูปภาพและตารางรวมกันไม่เกิน 6 รูป
- บทความปริทรรศน์ (review articles) ให้มีความยาวไม่เกิน 10,000 คำ, เอกสารอ้างอิงไม่เกิน 100 ข้อ, รูปภาพและตารางรวมกันไม่เกิน 10 รูป
- รายงานผู้ป่วย (case report) ให้มีความยาวได้ 1,500 คำ, รูปภาพและตาราง 1-2 รูป/ตาราง, เอกสารอ้างอิงไม่เกิน 20 ข้อ
- จดหมายให้มีความยาวได้ 500 คำ
- บทบรรณาธิการ

การเตรียมต้นฉบับ

- **เกณฑ์การเขียนบทความ**
 1. อธิบายเนื้อหาของบทความหรือวิเคราะห์ข้อมูลที่นำมาให้ชัดเจน
 2. หากต้นฉบับมีข้อผิดพลาดของรูปแบบหรือมีความไม่สมบูรณ์ขององค์ประกอบในบทความ บทความนั้นจะถูกส่งกลับไปยังผู้เขียนเพื่อทำการแก้ไขต่อไป

3. แก้ไขปรับปรุงเนื้อหาของต้นฉบับตามคำแนะนำของผู้ประเมินบทความ
- หากมีการเขียนบทความโดยกลุ่ม กรรมการระบุชื่อผู้เขียนทุกคน และระบุชื่อผู้วิจัยหลักให้ชัดเจน
- ควรแสดงความขอบคุณแก่บุคคลที่ไม่ได้มีส่วนร่วมในการเขียนบทความ แต่มีส่วนช่วยเหลือโดยตรงในการวิจัย เช่น ผู้ช่วยทางเทคนิค, ที่ปรึกษาด้านการเขียนบทความ, ผู้สนับสนุนทุนและวัสดุในการทำงานวิจัย เป็นต้น ไว้ในกิตติกรรมประกาศ (acknowledgements)
- บทความที่ส่งมาจะต้องเป็นเรื่องที่ไม่เคยตีพิมพ์ที่ไหนมาก่อน และผู้เขียนจะต้องไม่ส่งบทความเพื่อไปตีพิมพ์ในวารสารฉบับอื่นในเวลาเดียวกัน

หลักเกณฑ์สำหรับผู้เขียนบทความ

- ผู้เขียนบทความต้องไม่มีเจตนาส่งข้อมูลเท็จ
 - บทความที่ส่งมาต้องเป็นผลงานของตนเอง
 - ผู้เขียนบทความจะต้องไม่ส่งบทความที่เคยลงตีพิมพ์ในวารสารอื่น โดยไม่ระบุว่าท่านได้เสนอผลงานนั้นในวารสารใดบ้างอย่างถูกต้องและสมเหตุสมผล
 - ต้องระบุรายชื่อผู้เขียนทุกคนตามความเป็นจริง
 - ผู้เขียนบทความต้องส่งต้นฉบับที่ได้รับการรับรองที่แท้จริง
 - ผู้เขียนบทความต้องไม่ใช้วิธีการศึกษาที่มีผู้เผยแพร่มาก่อน โดยไม่ได้รับการอนุมัติจากเจ้าของลิขสิทธิ์
- **หน้าแรก (Title page)** เขียนเป็นภาษาไทยและภาษาอังกฤษ ประกอบด้วย
 - (1) ชื่อ สกุลของผู้เขียน
 - (2) ชื่อเรื่องอย่างย่อ ที่สื่อความหมายและชี้ให้เห็นสาระสำคัญของเนื้อหาในต้นฉบับบทความ
 - (3) สถานที่ทำงาน
 - (4) เบอร์โทรศัพท์, เบอร์แฟกซ์ และ e-mail address ของผู้เขียน
 - **บทคัดย่อ (Abstract)** ต้องมีทั้งภาษาไทยและภาษาอังกฤษมีความยาวไม่เกิน 250 คำ โดยเรียงลำดับเนื้อหา ดังนี้
 - (1) วัตถุประสงค์ (Purpose)
 - (2) วิธีการศึกษา (Methods)
 - (3) ผลการศึกษา (Results)
 - (4) สรุป (Conclusions)
 - **คำสำคัญ (Keyword)** ระบุไว้ได้บทคัดย่อ มีความยาว 4 – 6 คำ
 - **ต้นฉบับ (Manuscript)** เป็นภาษาอังกฤษ
 - **เนื้อเรื่อง (Text Formatting)** ให้ลำดับความสำคัญของเนื้อหา ดังนี้คือ บทนำ (introduction), วิธีการศึกษา (methods), ผลการศึกษา (results), วิจารณ์ (discussion), บทขอบคุณ (acknowledgements), เอกสารอ้างอิง (references), ตารางและรูปภาพประกอบ (tables and figures) โดยต้นฉบับจะต้องใช้รูปแบบ ดังนี้
 - (5) ใช้ตัวพิมพ์มาตรฐาน เช่นภาษาอังกฤษ ใช้ตัวอักษร “Times Roman” ขนาด 10 point ภาษาไทยใช้ ตัวอักษร “Angsana New” ขนาด 12 point
 - (6) พิมพ์ข้อความสำคัญด้วยตัวเอน
 - (7) ตั้งค่าเลขหน้าโดยอัตโนมัติ

- (8) ไม่ใช่ “field functions”
- (9) ใช้ปุ่ม “Tab” เมื่อขึ้นย่อหน้าต่อไป
- (10) เลือกคำสั่งตาราง (Table) เมื่อต้องการพิมพ์ตาราง
- (11) หากใช้โปรแกรม “Microsoft Word 2007” ให้ใช้โปรแกรม “Microsoft equation editor” หรือโปรแกรม “Math Type”
- (12) ส่งต้นฉบับในรูปแบบของแฟ้มข้อมูล โดยบันทึกข้อมูลเป็นไฟล์ “.doc” และห้ามบันทึกเป็นไฟล์ “.docx”

- หัวข้อ (headings) ไม่ควรมีขนาดต่าง ๆ มากกว่า 3 ระดับ

- คำย่อ (abbreviations) จะต้องมีคำเต็มเมื่อปรากฏเป็นครั้งแรกในบทความ หลังจากนั้นสามารถใช้คำย่อเหล่านั้นได้ตามปกติ

- เฉียงอรรถ (footnotes) คือ การอ้างอิงข้อความที่ผู้เขียนนำมากล่าวแยกจากเนื้อหาอยู่ตอนล่างของหน้า โดยใส่หมายเลขกำกับไว้ท้ายข้อความที่คัดลอกหรือเก็บแนวคิดมา และจะไม่เขียนเชิงอรรถเอาไว้ที่หน้าแรกของบทความ ถ้าต้องการแสดงที่มาของตารางหรือภาพประกอบให้ใช้เครื่องหมายแทนตัวเลข โดยเขียนไว้ที่ส่วนล่าง ของหน้า หรือใช้เครื่องหมายดอกจัน (*) เพื่อแสดงความหมายของคำหรือข้อมูลทางสถิติ

- กิตติกรรมประกาศ (acknowledgements) เป็นการแสดงความขอบคุณแก่ผู้ที่ช่วยเหลือในการทำวิจัย หรือผู้สนับสนุนทุนการวิจัย เป็นต้น โดยจะเขียนไว้ก่อนเอกสารอ้างอิงและควรเขียนชื่อสถาบันที่ให้การสนับสนุนทุนการวิจัย โดยใช้ชื่อเต็ม

- ตาราง (tables)

- (1) ให้เขียนหมายเลขตารางเป็นเลขอารบิก
- (2) ให้เรียงตามลำดับที่ของตารางอย่างต่อเนื่องกันจาก 1, 2, 3,
- (3) การอธิบายผลในตารางต้องไม่ซ้ำซ้อนกันและมีใจความกระชับรัดกุม และมีคำอธิบายกำกับไว้เหนือตาราง
- (4) เขียนคำอธิบายเพิ่มเติมเกี่ยวกับแหล่งที่มาของเอกสารอ้างอิงไว้ที่ใต้ตาราง
- (5) เฉียงอรรถ (footnotes) ของตารางจะเขียนไว้ใต้ตารางหรือใช้เครื่องหมายดอกจัน (*) เพื่อแสดงความหมายของคำหรือข้อมูลทางสถิติ

- รูปภาพ (figures)

- (1) ให้ใช้โปรแกรมกราฟฟิคคอมพิวเตอร์ในการวาดรูป
- (2) รูปภาพที่เป็นลายเส้นควรใช้รูปแบบ EPS ในการวาดเส้นรูปภาพและรูปภาพที่เป็นโทนาลีควรใช้รูปแบบ TIFF ในการได้เจดสี
- (3) รูปภาพทุกรูปจะต้องมีหมายเลขและคำบรรยายภาพกำกับไว้ใต้ภาพ โดยใช้ชื่อรูปภาพเป็น “Fig” ตามด้วยลำดับที่ของรูปภาพ เช่น “Fig1” เป็นต้น

- เอกสารอ้างอิง (references) เรียงลำดับเลขการอ้างอิงตามเอกสารอ้างอิงท้ายบทความ และใช้ตาม Vancouver style การอ้างอิงถึงชื่อนักคิด ถ้ามีผู้เขียนมากกว่า 6 คน ให้ใส่ชื่อ 6 คนแรก แล้วตามด้วย et al. ส่วนการเขียนเอกสารอ้างอิงท้ายบทความ การย่อชื่อวารสาร ให้ใช้ตาม Index Medicus โดยศึกษาได้ในเว็บไซต์ <http://www.medscape.com/home/search/indexMedicus/IndexMedicus-A.html>

กรุณาลงนามในแบบฟอร์มการส่งบทความเพื่อขอตีพิมพ์ เพื่อแสดงว่าผู้เขียนได้อ่านเกณฑ์การเขียนบทความทั้งหมด

ตัวอย่างการเขียนเอกสารอ้างอิง (references) กรุณาดูในหัวข้อ “Instruction to authors”



The Thai Journal of Orthopaedic Surgery

Acknowledgements to Reviewers 2017

Pongsak Yuktanandana
Editor in Chief

We are fortunate to have an outstanding group of reviewers who kindly volunteer their time and effort to review manuscripts for *The Thai Journal of Orthopaedic Surgery*. They are critical team players in the continued success of the journal, ensuring a peer review process of the high integrity and quality. The editor would like to thank the following reviewers who provided their expertise in evaluating manuscripts for *The Thai Journal of Orthopaedic Surgery* during 2017. A special thanks goes to Supawinee Pattanasoon for being our managing editor.

List of reviewers:

Apipop Kritsaneephaiboon
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