Modified Kocher-Langenbeck approach for the treatment of posterior wall or column acetabular fractures: The one-incision two-window method

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) For matched studies, give matching criteria and number of exposed and unexposed	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9

Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	8-10
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

Modified Kocher-Langenbeck approach for the treatment of posterior wall or column acetabular fractures: The one-incision two-window method

Running Title: Modified K-L Approach for Posterior Acetabular Fractures

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Competing interest

The authors declare that they have no competing interests. They received no financial support for the research, authorship, and/or publication of this article.

Abstract

Background: The Kocher-Langenbeck (K-L) approach is the standard method for the treatment of posterior wall or column acetabular fractures. This approach allows direct access to the posterior structures of the acetabulum, but is limited cranially and caudally by the neurovascular bundle. The present study was conducted to assess the quality of reduction and the incidence of complications in patients who underwent the modified “one-incision two-window” K-L approach.

Design: Retrospective case series.

Setting: Single academic Level 1 trauma center.

Patients/Participants: Thirteen consecutive patients from 2015 to 2017 who sustained an acute, displaced posterior wall or column acetabular fracture.

Intervention: Open reduction and internal fixation through the modified “one-incision two-window” K-L approach.

Main Outcome Measurements: Radiographic reduction quality, incidence of complications, visual analogue scale score, modified Harris hip score, and satisfaction rate.

Results: Among thirteen consecutive patients, seven patients were classified as having a transverse with or without posterior wall fracture (group 1) and six patients had a solitary posterior wall fracture (group 2). The mean operation time, mean intraoperative blood loss, and mean incision wound length were estimated to be 103.8 min (60-120 min), 373.1 mL (100-700 mL), and 9.7 cm (8.0-13.0 cm), respectively. The radiographic quality of reduction was graded as anatomical reduction (maximum residual displacement [MRD] ≤ 2 mm) in all

cases, according to Matta's criteria. Concerning the incidence of complications, there were no iatrogenic neurovascular injury, no surgical site infections, and no osteonecrosis of the femoral head or heterotopic ossification in this cohort. One patient in group 1 experienced deep vein thrombosis in the lesion leg. Another two patients in group 2 developed posttraumatic osteoarthritis, with one diagnosed as Tonnis grade I lesion and the other as Tonnis grade III lesion. With respect to the clinical treatment outcome, the mean visual analogue scale (VAS), mean modified Harris Hip Score (mHHS) and subjective satisfaction rate were 1.7 (1.0-2.0), 90.6 (81-100), and 84.6% (80%-90%), respectively. Although there was no significant difference in the satisfaction rate (82.9% vs. 87.0%, $P = 0.941$) at 12 months after surgery, group 1 patients had more increased VAS score (2.0 vs. 1.2, $P = 0.016$) and more decreased mHHS (87.7 vs. 94.6, $P = 0.014$) than group 2 patients.

Conclusions: Our pilot study confirmed that the "one-incision two-window" K-L approach is a simple, safe, reliable, and effective way to manage acute, displaced posterior wall or column acetabular fractures.

Level of evidence: Therapeutic study, level IV.

Key Words: one-incision two-window method, posterior wall acetabular fracture, posterior column acetabular fracture, modified Kocher-Langenbeck approach

1 **Background**

2 According to the classification of Judet and Letournel, posterior wall acetabular
3 fracture is the most common type of elementary fracture pattern and transverse posterior
4 wall fracture is the most common associated fracture pattern.^{1,2} As in the case with other
5 displaced acetabular fracture types, the best treatment results are predicted on the basis of
6 anatomic fracture reduction and rigid fixation.^{1,3} Ordinarily, the Kocher-Langenbeck (K-L)
7 approach is the standard method for the treatment of posterior wall or column acetabular
8 fractures.⁴ This approach allows direct access to the outer surface of the posterior
9 structures and indirect access to the superior wall and quadrilateral surface; however, it is
10 limited cranially and caudally by the superior gluteal neurovascular bundle (SGB) and the
11 medial circumflex femoral artery (MCFA), respectively.⁴ Thus, various modifications of the
12 K-L approach had been reported with varying clinical results.⁵⁻⁸ Some techniques aimed at
13 sparing the division of the short external rotators (SERs), thus preventing iatrogenic damage
14 to the vascularity of the femoral head and of the fracture fragments.^{5,6} Others flip a slice of
15 the greater trochanter anteriorly with the attached gluteus medius and vastus lateralis
16 muscles to provide free access to the superior wall area and avoid damage to the hip
17 abductor muscles due to vigorous retraction.^{7,8} However, posttraumatic osteoarthritis
18 (PTOA), osteonecrosis of the femoral head (ONFH), heterotopic ossification (HO), osteotomy
19 nonunion, and neurovascular injury still tend to diminish the treatment outcome of

acetabular fractures despite adequate surgical exposure of the operative field for good fracture reduction and rigid fixation.⁹⁻¹¹

The current study reviews our experience with a modification of the K-L approach in the treatment of acute, displaced posterior wall or column acetabular fractures. The modification involves a minimally invasive approach by which the neurovascular bundles are well protected from undue traction or damage by avoiding vigorous retraction. The study was conducted to assess the quality of reduction and the incidence of complications in patients who underwent the modified “one-incision two-window” K-L surgical approach.

Surgical technique (Fig. 1,2,3)

The patient is placed in a lateral decubitus position with the affected side uppermost. No skeletal traction is applied to the injured hip. In line with the longitudinal axis of the femur, skin incision is started 5 cm distal to the posterior tip of greater trochanter (PTGT). After passing the PTGT, the skin incision is continued 5 cm further in the direction of the posterior superior iliac spine. The iliotibial tract is divided sharply in line with its fibers, and the gluteus maximus muscle is split bluntly along the raphe, which indicates the inter-neurovascular interval between the SGB and the inferior gluteal neurovascular bundle for the upper one-third and lower two-third of the gluteus maximus muscle, respectively. After removing the layer of fat and bursa covering the SERs, the insertions of the piriformis tendon and the conjoined tendon of the gemellus and obturator internus muscles are meticulously identified and divided 1 cm lateral from their femoral insertions to protect the

MCFA, which helps supply blood to the neck and head of the femur. By retracting the divided tendon stumps gently, the first window is created to expose the posterior wall, ischial body, and ischial tuberosity. In this window, the displaced fracture fragments can be reduced and fixed provisionally with Kirschner wires. The posterior column may be stabilized first with a small reconstruction plate along the greater sciatic notch to hold the reduction. Final plate fixation is then completed using a precontoured long pelvic reconstruction plate that is slid under the gluteal muscles, in line with the posterior rim of the acetabulum, and spans from the ischium to the superior wall area. After fixing the distal end of the plate with two screws into its concave bend, another window is created through the tensor fascia lata and gluteal muscles for exposure of the proximal screw holes of the plate. With the assistance of finger palpation in hip abduction position, the proximal screws can be applied accurately and safely. After definite fracture fixation and delicate soft tissue debridement, the piriformis and conjoined tendons are reattached to their femoral stump footprint by using 1-0 Vicryl suture. At the end of the surgical procedure, the wound is closed by layers without placing a drain. Postoperatively, no prophylaxis (indomethacin or radiation) against HO is used. An intermediate-restrictive rehabilitation protocol is suggested, including immediate toe-touch weightbearing with progression to full weightbearing by 12 weeks.¹²

60 **Methods**

61 ***Participating patients and study significance***

62 Between January 2015 and December 2017, a total of 13 consecutive patients (10 men
63 and 3 women) were treated by a single surgeon (TTY) for acute, displaced posterior wall or
64 column acetabular fractures by using the modified “one-incision two-window” K-L surgical
65 approach. Among these patients, seven had transverse with or without posterior wall
66 acetabular fracture and six had posterior wall acetabular fracture alone. At the time of study
67 enrollment, we summarized the collected data, which included demographic characteristics,
68 fracture pattern, surgery details, and radiographic and clinical outcome measurements,
69 among others. These data were analyzed to study the effectiveness of the modified
70 “one-incision two-window” K-L surgical approach in the treatment of acute, displaced
71 posterior wall or column acetabular fractures. The modification involves a minimally
72 invasive approach that is believed to provide a simple, safe, reliable, and effective way to
73 manage these complex lesions.

74 ***Radiographic and clinical outcome measurements***

75 Regular radiographic and clinical assessments were carried out immediately before
76 and after surgery – that is, preoperatively; immediately after surgery; and at 1, 2, 3, 6, and
77 12 months postoperatively. Computed tomography scan of the pelvis with
78 three-dimensional reconstruction was routinely performed preoperatively to help confirm
79 the fracture types according to the classification of Judet and Letournel.^{1,2} The radiographic

quality of fracture reduction was assessed by measuring the maximum residual displacement (MRD) of the walls and columns on digitized, standard anteroposterior and two oblique pelvic views. and then graded according to Matta's criteria, as follows: anatomical (MRD $\leq$ 2 mm), satisfactory (MRD between 2 and 3 mm), and unsatisfactory (MRD $\geq$ 3 mm).¹³⁻¹⁶ PTOA was evaluated using the Tonnis classification modified by adding quantitative measurements of joint space narrowing and joint congruence to differentiate early lesions.¹⁷ Patients were clinically evaluated for abduction power according to the Medical Research Council grading system, and for the presence of a lurch gait pattern or a Trendelenburg sign. The overall clinical outcomes were assessed according to the visual analog scale (VAS) score, modified Harris Hip Score (mHHS), and subjective satisfaction rate.¹⁸ The mean follow-up period averaged 20.6 months (range, 12-36 months).

Statistical analysis

Between-group comparisons were performed using univariable analysis. Mann-Whitney U-test and Fisher's exact test were used to analyze numerical and nominal variables, respectively. Significance was set at $P < 0.05$ (two-sided). SPSS 12.0 (SPSS Inc., Chicago, IL, USA) was used for all analyses.

Ethics statement

The data were analyzed after the approval by the ethics committee (institutional review board) of Chang Gung Memorial Hospital, Taiwan (reference no. 201801360B0).

Results

Analyses of patient characteristics and related variables (Table 1)

In this 3-year-long study, we enrolled 13 patients who underwent the modified “one-incision two-window” K-L surgical approach for the treatment of acute, displaced posterior wall or column acetabular fractures. Among them, seven patients were classified as having a transverse with or without posterior wall fracture (group 1) and six patients had a solitary posterior wall fracture (group 2). The mean patient age and mean body mass index were 43.5 years (24-67 years) and 26.1 kg/m² (20.8-38.0 kg/m²), respectively; 10 patients (76.9%) were men and 3 patients (23.1%) were women. One patient in group 1 had ipsilateral sciatic nerve (SN) injury and presented with preoperative drop foot deformity. The mean operation time, mean intraoperative blood loss, and mean incision wound length were estimated to be 103.8 min (60-120 min), 373.1 mL (100-700 mL), and 9.7 cm (8.0-13.0 cm), respectively. Although there was a trend toward a longer operation time (111 min vs. 95 min, $P = 0.123$) and more intraoperative blood loss (442.9 mL vs. 291.7 mL, $P = 0.071$) in group1, between-group comparison revealed no significant differences in all these demographic characteristics and related variables (all $P \geq 0.071$).

Analyses of the quality of reduction and the incidence of complications (Table 2)

With respect to the quality of fracture reduction, we measured the MRD of the walls and columns on plain radiographs taken immediately after surgery. We found that none of

the residual wall or column fracture displacements were > 2 mm; thus, the radiographic quality of reduction was graded as anatomical reduction (MRD $\leq$ 2 mm) in all cases, according to Matta's criteria. All fractures achieved union, and there was no loss of reduction and fixation during the follow-up period. Concerning the incidence of complications, there were no iatrogenic SN or SGB injury, no superficial or deep surgical site infections (SSIs), and no ONFH or HO in this cohort. However, one patient in group 1 developed deep vein thrombosis (DVT) and two patients in group 2 showed PTOA on follow-up radiographs. Because acetabular fracture surgery may confer a high risk for bleeding with anticoagulation, the patient with DVT received conservative treatment through the shared decision-making program. Until the date of the final follow-up, this patient did not have proximal extension of thrombosis, pulmonary embolism (PE) event, or recurrent DVT/PE. With respect to PTOA, one patient was found to have Tonnis grade I lesion (4 months after surgery, asymptomatic and without progression) and another patient was found to have Tonnis grade III lesion (6 months after surgery, symptomatic progression). Because of failed conservative treatment, the patient with advanced PTOA underwent total hip arthroplasty (THA) at 6 months after posterior wall acetabular fracture dislocation.

Analyses of clinical outcome measures at 12 months after surgery (Table 3)

After the exclusion of 1 patient who underwent THA because of Tonnis grade III PTOA, 12 patients were included in the analyses of clinical outcome measures at 12 months after surgery. The mean VAS score, mean mHHS, and subjective satisfaction rate were 1.7

140 (1.0-2.0), 90.6 (81-100), and 84.6% (80%-90%), respectively. Although there was no
141 significant difference in satisfaction rate (82.9% vs. 87.0%, $P = 0.941$), group 1 patients had
142 more increased VAS score (2.0 vs. 1.2, $P = 0.016$) and more decreased mHHS (87.7 vs. 94.6,
143 $P = 0.014$) than group 2 patients.

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Discussion

Our pilot study revealed that the modified “one-incision two-window” K-L surgical approach is a simple, safe, reliable, and effective way to manage acute, displaced posterior wall or column acetabular fractures. The proposed approach used a curved skin incision averaging 9.7 cm (range, 8-13 cm) in length and provided an adequate working space for manipulation by the surgeon even in patients with severe obesity (SDC 1). Within the first window, fractured lesions were well exposed, reduced, and fixed provisionally. The precontoured long pelvic reconstruction plate for definite fracture fixation could also be easily placed in line with the posterior rim of the acetabulum by sliding under the gluteal muscles. Without vigorous retraction, distal and proximal plate screws could be accurately and safely inserted in direct view through window 1 and window 2, respectively. With this technique, our results showed that an anatomical reduction with MRD ≤ 2 mm was achieved in all patients. Further, an excellent functional outcome was attained in our series, average, as assessed using the mHHS system.

The aim of surgical treatment of displaced acetabular fractures is to establish a stable anatomical reduction with a functional, mobile, and pain-free hip.^{13,14} The accuracy of fracture reduction and internal fixation correlates strongly with functional outcomes.^{10,15} The conventional K-L approach is the standard method for posterior wall and column acetabular fractures; however, access to the superior wall area is limited.⁷ By using this approach, Matta reported an 80% anatomical reduction rate for transverse posterior wall

acetabular fracture types, and fair or poor clinical results as measured using the d'Aubigne score in 30% of cases.¹ In the series of Gansslen et al., the authors reported a similar result with a 76% anatomical reduction rate and only 56.7% of their patients had a functionally satisfactory result.¹⁹ Although Bogdan et al. reported a 100% anatomical reduction rate and functionally good results, as many as 18% of their patients required additional anterior approach to facilitate reduction and fixation.²⁰ Some other surgeons used a trochanteric flip osteotomy to improve visualization of the superior wall area of the acetabulum from the conventional K-L exposure, and reported good radiographic and clinical results.^{7,8} Additional bone and soft tissue procedures might allow better visualization, more accurate reduction, and easier fixation of the cranial acetabular fragments; however, the more extensile the approach used, the higher the rate of associated surgical risk and complications. For example, trochanteric nonunion is believed to occur in 2%-15% of cases following trochanteric osteotomy.²¹

Without adding a bone or soft tissue procedure to the conventional K-L approach, vigorous manipulations for visualization, reduction of the fractured fragments, and even screw fixation of a bridging plate may lead to substantial stretching and laceration of the surrounding soft tissues, which subsequently may contribute to iatrogenic neurovascular injuries, HO, ONFH, and SSIs, among others.²²⁻²⁴ A 2% rate of intervention-related nerve injury (IRNI) associated with acetabular fractures was reported in a retrospective study of prospectively collected data from the German Pelvic Trauma Registry.²³ In that 12-year-long

study including a total of 2236 patients from 29 hospitals, Lehmann et al. found that the K-L approach was associated with the highest proportion of IRNIs.²³ Apart from the SN, which is typically injured in posterior approaches, the inferior ramification of the deep SGB is considered at risk when the gluteal muscles is retracted > 3 cm above the greater trochanter.²³⁻²⁵ Likewise, vigorous retraction might increase soft tissue injury, lead to necrotic muscle in the injury zone, and increase the incidence of HO and SSIs.²⁶ Some researchers have suggested a modification involving sparing the division of the SERs, and declared that it could prevent iatrogenic damage to the MCFA and thus reduce the risk of secondary ONFH.^{5,6} However, there was no direct evidence supporting this hypothesis.

Our proposed technique provided two working windows for surgical manipulation. One was used for controlling the posterior structures by gently elevating the SER flap, which preserved the MCFA and protected the SN. The other was used for governing the superior wall area by splitting the gluteal muscles, which avoided vigorous retraction and prevented SGB injury, HO, or SSIs. Despite the promising radiographic and clinical results, we encountered one case of DVT (7.7%) and two cases of PTOA (15.4%) in the present study. Major trauma and surgery are major situational triggers for DVT/PE.²⁷ Kinking of femoral vessels at the time of impact and an intrapelvic hematoma compressing the pelvic vasculature might contribute to thrombus formation in the lesion limb after injury to the posterior structures of the acetabulum.²⁷⁻²⁹ Although acetabular fracture surgery confer a high risk for bleeding with anticoagulation, vigilance with appropriate thromboprophylaxis

should prevail throughout the clinical pathway in these high-risk patients. PTOA is still one of the most common complications of acetabular fractures and usually requires THA thereafter.³⁰ Even if anatomical fracture reduction was achieved in the present study, the possibility of PTOA development could not be excluded owing to the increased rate of chondrocyte apoptosis in intra-articular acetabular fractures with or without hip dislocation.²²

This study has several limitations. First, this pilot study was a retrospective case series study with a small number of patients. Additionally, there was no control group for comparison to provide reliable evidence for the superiority of the proposed technique. Second, although the major fracture prototype was a posterior wall or column fracture, several specific types of acetabular fractures were diagnosed in the current study. This could cause bias while analyzing the data, produces false conclusions, and is potentially misleading. Prospectively randomized controlled trials are needed in the future to compare this modified technique with the conventional approach for the specified fracture type.

Conclusion

This study introduced a modified K-L approach – the one-incision two-window method. Through this technique, adequate working space was provided with good preservation of the surrounding vital structures and without undue traction or damage secondary to vigorous retraction. The fracture reduction and functional outcome were anatomical and excellent, respectively. Further, there were no additional approach-related complications.

Thus, we conclude that the proposed technique is a simple, safe, reliable, and effective way to manage acute, displaced posterior wall or column acetabular fractures.

Abbreviation

K-L approach: Kocher-Langenbeck approach; MRD : maximum residual displacement; VAS: visual analogue scale; mHHS: modified Harris Hip Score; SGB: superior gluteal neurovascular bundle; MCFA: medial circumflex femoral artery; SERs: short external rotators; PTOA: posttraumatic osteoarthritis; ONFH: osteonecrosis of the femoral head; HO: heterotopic ossification; PTGT: posterior tip of greater trochanter, TTY: Tien-Yu, Yang; SN: sciatic nerve; SSI: surgical site infection; DVT: deep vein thrombosis; PE: pulmonary embolism; THA: total hip arthroplasty; SDC: supplemental digital content; IRNI: intervention related nerve injury.

Declaration

Ethic approval and consent to participate

The authors analyzed the datas after approval by the ethic committee (Institutional Review Board) of the Chang Gung Memorial Hospital in Taiwan (Reference number: 201801360B0). We did not obtain informed consent from the patient due to a statement of this committee, that analyzing patient data retrospectively requires no informed consent. However, patient records and information were anonymized and de-identified prior to analysis

Consent for publication

There is no any individual person's data in this manuscript.

Availability of data and materials

All data and information about materials are in the paper and/or available from the first author.

248 **Competing interest**

249 The authors declare that they have no competing interests. They received no financial
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252 There is no funding from any institution or company in this study

253 **Authors Contribution**

254 TYY and KCH participated in the literature search, study design, data collection, data analysis
255 and interpretation, writing, and critical revision. PYC and TWH participated in the data
256 collection, data analysis and interpretation, writing, and critical revision.

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Figure legends

Figure 1. The modified “one-incision two-window” Kocher-Langenbeck surgical approach. (A) Posterior structures of the right hip joint. (B) Window 1 (W1) is used for controlling the posterior structures by gently elevating the short external rotators (SERs) as a flap, which preserves the medial circumflex femoral artery (MCFA) and protects the sciatic nerve (SN). After provisional reduction and fixation, a precontoured long pelvic reconstruction plate can be slid under the gluteal muscles, in line with the posterior rim of the acetabulum, spanning from the ischium to the superior wall area. Through this window, the distal end of the plate is fixed with two screws into its concave bend. (C) Window 2 (W2) is used for governing the superior wall area by splitting the gluteal muscles, which avoids vigorous retraction and prevents superior gluteal neurovascular bundle (SGB) injury. Through this window, the proximal plate screws can be applied accurately and safely in direct view.

Figure 2. The procedure of making the second window. (A) Applying the distal screws at ischium through the first window. (B&C) Anteriorly dissect the fascia lata upon the fascia layer. (D) Incise the fascia lata at the proximal screw level, then split the gluteal muscle with finger to the plate to make the second window.

Figure 3. Picture A represents the first and second windows. Picture B&C represent the proximal screws applying from the second window with verification by fluoroscopy.

Supplemental digital content

SDC 1. A 28-year-old male patient with a body mass index of 33.2 kg/m² suffered from left posterior wall acetabular fracture and hip dislocation secondary to a motor vehicle accident.

336 (A and B) Preoperative anteroposterior pelvic view and computed tomography scan of the
337 pelvis with three-dimensional reconstruction. (C and D) Postoperative oblique pelvic views.
338 (E) Photograph taken immediately after completing the procedure through the modified
339 “one-incision two-window” Kocher-Langenbeck approach. The length of the incision wound
340 was 9 cm.

Table 1. Demographic data of patients treated using the modified Kocher-Langenbeck approach.

	Total	Group 1	Group 2	P value[§]
	(n = 13)	(n = 7)	(n = 6)	
Mean age (yrs, range)	43.5 (24-67)	48.4 (28-67)	37.8 (24-58)	0.229
Gender (n, %)				1.000
Male	10 (76.9%)	5 (71.4%)	5 (83.3%)	
Female	3 (23.1%)	2 (28.6%)	1 (16.7%)	
Bone mass index (kg/m²) (mean, range)	26.1 (20.8-38.0)	25.4 (20.8-38.0)	27.0 (22.6-33.2)	0.600
Preoperative sciatic nerve injury (n, %)	1 (7.7%)	1 (14.3%)	0 (0%)	0.377
Operation time (min) (mean, range)	103.8 (60-120)	111 (85-115)	95 (60-120)	0.123
Intraoperative blood loss (mL) (mean, range)	373.1 (100-700)	442.9 (300-700)	291.7 (100-500)	0.071
Incision wound length (cm) (mean, range)	9.7 (8-13)	9.7 (8-13)	9.7 (9-10)	0.946

Group1, transverse with or without posterior wall acetabular fracture; group 2, posterior wall acetabular fracture alone.

[§] P value, the calculated probability showing that there is no difference in the results between group 1 and group 2.

Table 2. Quality of reduction and incidence of complications after surgery with the modified Kocher-Langenbeck approach.

	Total	Group 1	Group 2	P value[§]
	(n = 13)	(n = 7)	(n = 6)	
Radiographic reduction (n, %)				1.000
Anatomical ($\leq 2\text{mm}$)	13 (100%)	7 (100%)	6 (100%)	
Others ($> 2\text{mm}$)	0 (0%)	0 (0%)	0 (0%)	
Complications (n, %)				
Sciatic nerve injury	0 (0%)	0 (0%)	0 (0%)	1.000
Superior gluteal neurovascular injury	0 (0%)	0 (0%)	0 (0%)	1.000
Deep vein thrombosis	1 (7.7%)	1 (14.3%)	0 (0%)	0.429
Surgical site infection	0 (0%)	0 (0%)	0 (0%)	1.000
Heterotopic ossification	0 (0%)	0 (0%)	0 (0%)	0.165
Osteonecrosis of femoral head	0 (0%)	0 (0%)	0 (0%)	1.000
Post-traumatic osteoarthritis	2 (15.4%)	0 (0%)	2 (33.3%)	0.165

Group1, transverse with or without posterior wall acetabular fracture; group 2, posterior wall acetabular fracture alone.

[§] P value, the calculated probability showing that there is no difference in the results between group 1 and group 2.

Table 3. Clinical outcomes at 12 months after surgery with the modified Kocher-Langenbeck approach.

	Total	Group 1	Group 2	P value[§]
	(n = 12)	(n = 7)	(n = 5)	
Visual analogue scale score (mean, range)	1.7 (1-2)	2.0 (2-2)	1.2 (1-2)	0.016*
Modified Harris hip score (mean, range)	90.6 (81-100)	87.7 (81-94)	94.6 (91-100)	0.014*
Satisfaction rate (%) (mean, range)	84.6 (80-90)	82.9 (80-90)	87.0 (80-90)	0.941

Group1, transverse with or without posterior wall acetabular fracture; group 2, posterior wall acetabular fracture alone.

[§] P value, the calculated probability to determine whether there is a difference in the results between group 1 and group 2.

* The difference is significant ($P < 0.05$).

Figure 1

Figure 2

Figure 3

Figures

Figure 1

The modified “one-incision two-window” Kocher-Langenbeck surgical approach. (A) Posterior structures of the right hip joint. (B) Window 1 (W1) is used for controlling the posterior structures by gently elevating the short external rotators (SERs) as a flap, which preserves the medial circumflex femoral artery (MCFA) and protects the sciatic nerve (SN). After provisional reduction and fixation, a precontoured long pelvic reconstruction plate can be slid under the gluteal muscles, in line with the posterior rim of the acetabulum, spanning from the ischium to the superior wall area. Through this window, the distal end of the plate is fixed with two screws into its concave bend. (C) Window 2 (W2) is used for governing the superior wall area by splitting the gluteal muscles, which avoids vigorous retraction and prevents superior gluteal neurovascular bundle (SGB) injury. Through this window, the proximal plate screws can be applied accurately and safely in direct view.

Figure 2

The procedure of making the second window. (A) Applying the distal screws at ischium through the first window. (B&C) Anteriorly dissect the fascia lata upon the fascia layer. (D) Incise the fascia lata at the proximal screw level, then split the gluteal muscle with finger to the plate to make the second window.

Figure 3

(A) represents the first and second windows. (B&C) represent the proximal screws applying from the second window with verification by fluoroscopy.

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