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by Ahmed Khalifa

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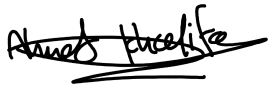
Corresponding author
Ahmed A. Khalifa



20-6-2021

Writing Issues

50	**Correctness**	
2	Text inconsistencies	
8	Punctuation in compound/complex sentences	
2	Confused words	
9	Determiner use (a/an/the/this, etc.)	
2	Incorrect phrasing	
5	Incomplete sentences	
1	Misplaced words or phrases	
1	Incorrect verb forms	
1	Faulty subject-verb agreement	
1	Mixed dialects of english	
4	Improper formatting	
3	Unknown words	
10	Misspelled words	
1	Comma misuse within clauses	
115	**Clarity**	
7	Unclear paragraphs	
81	Passive voice misuse	
17	Wordy sentences	
4	Unclear sentences	
5	Hard-to-read text	
1	Intricate text	
10	**Engagement**	
10	Word choice	

Unique Words

15%

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unique words

Rare Words

37%

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rare words

Word Length

4.5

Measures average word length

characters per word

Sentence Length

16.1

Measures average sentence length

words per sentence

67542 Revised Manuscript

2

2

Name of journal[1]: WORLD JOURNAL OF ORTHOPEDICS

Manuscript Type: systematic review and metanalysis

Title: Safety and efficacy of surgical hip dislocation in managing femoral head fractures: A systematic review and meta-analysis

Running title: SHD for managing FHFs[2], systematic review

Authors:

1-Ahmed A. Khalifa, M.D.[2], FRCS, MSc.* (ahmed_adel0391@med.svu.edu.eg), Orthopaedic Department, Qena faculty of medicine and University Hospital, South valley university 83523, Qena, Egypt.

2- Mohamed A. Haridy, MSc., MRCS (dr.haridy1988@yahoo.com), Ibri Regional Hospital, Ibri, Aldhahira governorate 511, Oman.

3-Ali Fergany, M.D. (ali.fergany.83@med.aun.edu.eg), Orthopaedic Department, Assiut University Hospital 71515, Assiut, Egypt.

ORCID number:

Ahmed A. Khalifa: 0000-0002-0710-6487

Mohamed A. Haridy: 0000-0002-0432-0154

Ali Fergany: 0000-0002-6358-8628

Author's contribution:

A.A.K. carried out the Study conception and design. M.A.H. and A.F. carried out data acquisition, A.A.K., M.A.H., and A.F. carried out interpretation of data. All authors drafted the manuscript and designed the figures and tables, A.A.K. did the critical revision. All authors discussed the results and commented on the manuscript. All authors read and approved the final manuscript and are responsible for the content and similarity index of the manuscript.

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*(CORRESPONDING AUTHOR)

Ahmed A. Khalifa M.D., FRCS, MSc.

Assistant Professor and Consultant of orthopedic and traumatology, Qena faculty of medicine and university hospital, South valley university, Qena, Egypt. Address: Kilo 6 Qena-Safaga highway, Orthopaedic and Traumatology Department, Qena University Hospital, South Valley University, Qena, Egypt (83523) Tel.: + 2 096 5337573 Fax.: + 20965337571 Web address: HTTP :// www.svu.edu.eg, ORCID ID: https://orcid.org/0000-0002-0710-6487

Abstract:

Background: Femoral head fractures (FHFs) are considered relatively uncommon injuries; however, Open reduction and internal fixation (ORIF) are preferred for most displaced fractures. Several surgical approaches had been utilized with controversial results; surgical hip dislocation (SHD) is among these approaches, with the reputation of being demanding and leading to higher complication rates. Aim: systematic review and meta-analysis to

determine the efficacy and safety of SHD in managing FHFs by reviewing the results reported in the literature.

Methods: Major databases including PubMed, Embase, Web of Science, and CENTRAL were searched to identify studies reporting on outcomes of SHD utilized as an approach in treating FHFs. We extracted basic studies data, surgery-related data, functional outcome, radiological outcomes, and postoperative complications. We calculated the mean differences (MDs) for continuous data with 95% confidence intervals (CIs) for each outcome and the odds ratio with 95% confidence intervals (CIs) for binary outcomes. $P < 0.05$ was considered significant.

Results: Our search retrieved nine studies meeting our inclusion criteria, with a total of 129 FHFs. The results of our analysis revealed that the average operation time was 123.74 minutes, while the average blood loss was 491.89 ml. After an average follow-up of 38.4 months, a satisfactory clinical outcome was achieved in 85% of patients, with 74% obtained anatomical fracture reduction. Overall complication rate ranged from 30% to 86%, with avascular necrosis (AVN), heterotopic ossification (HO), and osteoarthritis (OA) being the most common complications occurring at an incidence of 12%, 25%, and 16% respectively. Trochanteric flip osteotomy (TFO) nonunion and trochanteric bursitis as a unique complication of SHD occurred at an incidence of 3.4% and 3.8% respectively.

Conclusion: The integration of SHD approach for dealing with FHFs enables trauma surgeons to better management. It offered acceptable functional and radiological outcomes with a wide range of safety as regards the hip joint vascularity and the development of AVN, the formation of HO, and the development of posttraumatic OA; however, it still carries its unique risk of TFO nonunion and persistent lateral thigh pain.

Keywords: Femoral head; Pipkin fracture; surgical hip dislocation; Ganz; systematic review; meta-analysis

Core tip: In the past few years, surgical hip dislocation (SHD) had been adopted by many trauma surgeons as an approach for femoral head fractures (FHFs) management; the current systematic review and metanalysis collected data from the most recent literature showed the efficacy of this approach as regards to obtaining acceptable functional and radiological outcomes as well as resulting in relatively low complication rates when compared with other approaches reported in the literature. However, it carries some unique complications such as trochanteric bursitis and TFO nonunion.

Introduction:

Femoral head fractures are considered rare injuries resulting from high energy trauma, which is usually associated with posterior hip dislocation and rarely anterior subluxation [1, 2]; the rarity of this injury makes it difficult to report on large numbers of patients and the performance of high quality prospective randomized studies even more challenging [1, 3].

The commonly used classification system for this injury is the Pipkin classification, where four types were identified[17] according to the fracture location and the presence of associated injuries (Type I where the fracture fragment is distal to the fovea, Type II where the fracture fragment including or above the fovea, Type III if the fracture is associated with a femoral neck fracture, and Type IV if it was associated with acetabular wall fractures) [4].

The management of femoral head fractures follows a broad spectrum of options (primarily based on its Pipkin type), where conservative management is kept[18] for the minimally displaced Pipkin I fracture, and at the end of the spectrum, total hip arthroplasty (THA)[2] could be offered[19] for older patients with highly comminuted fractures [5].

The basic principles of intraarticular fracture management still apply to FHFs[2], where obtaining anatomical reduction and stable fixation (achieved by open reduction and internal fixation (ORIF)) is mandatory for good long-term results, the controversy exists regarding the optimum approach which should be used safely for ORIF [2, 3, 6], either anterior, lateral or posterior based approaches

including the use of safe surgical hip dislocation (SHD) which was initially described by Ganz et al. as a safe approach for management of different intraarticular hip pathologies with no or few complications especially those related to femoral head vascularity [3, 7].

One of the significant complications occurring either due to the trauma itself or as a consequence of surgical management is the AVN of the femoral head [2, 3]. After Ganz popularized the safety of SHD in regards to hip vascularity preservation [7], this encouraged more trauma surgeons to introduce this approach in the armamentarium of approaches in the management of the FHFs [2, 3, 6, 8].

As a trial to collect large data on these injuries, a systematic review was performed by Giannoudis et al. in 2009, pooling the data from 29 studies which constituted a total of 453 FHFs treated through different approaches, where they evaluated various aspects related to management; however, one drawback of this review was the heterogenicity of the reported studies, and the inclusion of relatively few numbers of patients (36 FHFs) treated through SHD [2]. Recently, more studies with a larger number of patients reported the utilization of SHD in the management of FHFs; this encouraged us to carry this systematic review and metanalysis to update the knowledge regarding the clinical, radiological outcomes as well as the safety (by reporting the incidence of complications) of using SHD in the management of FHFs.

Materials and methods:

Search Protocol and Information Sources

We conducted a systematic review according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [9]. PubMed, Embase, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) databases were searched for the last 20 years (till January 2021)

using a combination of the following search terms: femoral head fracture, Pipkin fracture, surgical hip dislocation, Ganz.

Eligibility Criteria, Study Selection, and Data Items

Retrieved results were imported into Endnote X9 software (Thomson Reuters, New York, NY, USA), where a check for duplicates was conducted. The titles and abstracts of the remaining articles were then screened, and the selection was based on the following exclusion criteria:

Articles published in languages other than English.

Reviews, guidelines, or classifications.

Letters to the editor or case reports, or conference papers

In vitro and animal experiment studies

Irrelevant studies.

Subsequently, full-text articles of potentially relevant studies were obtained and assessed for eligibility. We included studies that met the following inclusion criteria:

Prospective or retrospective cohorts or case series investigating SHD via a trochanteric flip osteotomy (TFO) (as described initially by Ganz [7]) as an approach to treat FHFs in adult populations or studies from which data could be extracted independently.

A minimum sample size of 5 patients.

The ability to extract data related to the outcomes of interest (data should be genuine and not reported in another study).

Data Collection Process:

Two independent reviewers reviewed the list of potentially eligible articles (they also performed data extraction), and a third reviewer was consulted, when necessary, to decide any uncertainties regarding eligibility. The following information was extracted from studies that met the inclusion criteria: the

name of the first author, year of publication, study design, number of cases, patients age and gender, classification of the fracture according to Pipkin classification system, the strategy of management (ORIF or fragment excision), type of the implant used for fixation, operation time, blood loss, length of follow-up time, and outcomes of interest including functional outcome, radiological outcome, complication rate, and reoperation or revision surgery details.

Summary Measures, Synthesis of Results, and Risk of Bias Across Studies: When mean or standard deviation values were not available in the publications, we used statistical methods described in previous literature to derive the needed numerical values [10]. We performed all data analyses using Review Manager version 5.4.1. (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014). We calculated the odds ratio with a 95% confidence interval (CI) for binary outcomes, while the mean difference with 95% CI for continuous outcomes was calculated.[35] To calculate the overall effect estimate with 95% CI, we used a fixed-effect model with the method of Mantel-Haenszel when there is no evidence of heterogeneity between studies. Otherwise, a random-effects model with the method of DerSiomonian and Laird was chosen.[36] Heterogeneity between studies was evaluated[37] using the Q statistic and I^2 test, which describes the percentage of[38] variability in the effect estimates. A P value of < 0.05 was considered significant.

Results

Study Selection:

The electronic search yielded 1002 references from the four databases. After excluding 192 duplicates, 810 records remained for a title and abstract screening. We had 18 relevant[41] articles for full-text screening, eight fulfilled the inclusion criteria, and ten were excluded[39] (one article not in English, six articles

were case reports or included less than five cases, two articles the data of interest could not be extracted and in one article the same data was reported in one of the included articles). The manual search of the included articles references imported one additional article. Nine studies [11-19] were ultimately included in the qualitative and quantitative analyses. The flow diagram of the study selection process is shown in (Figure 1).

Study Characteristics:

Nine studies included a total of 129 FHFs from which basic demographic data were extracted (the data on outcomes were extracted from 127 FHFs, as in one study [15], the authors reported missing the assessment of two patients in their results section). Two studies [15, 16] were prospective, while seven [11-13, 17-20] were retrospective. Across studies, the mean age was 38.2 years (ranged from 17 to 64). The average follow-up period was 38.4 months (ranged from 10.8 to 77). The majority of participants were males (76.4%). In one study [18], the fracture classification was not reported, while in the remaining eight studies, the fracture classification according to Pipkin was as follows, 77 (62.6%) type I and II, while 46 (37.4%) were type IV, and none (0%) were Pipkin type III. All patients underwent fixation (96.9%) except four (3.1%) patients who underwent fragment excision; no patient underwent THA as the primary management. Details for included studies are summarized in (Table 1).

Surgical data:

1-Associated intraarticular injuries: Regarding the intraarticular associated injuries (other than the primary fractures either in the femoral head or the acetabulum), in four studies [12, 14, 15, 19], the authors reported intraoperative diagnosis of Labral injuries at an incidence of 41.3% (33 out of 80 hips). Head impaction injury was reported in three studies [14, 15, 19], which occurred at an incidence of 23.5% (16 out of 68 hips).

2-Operation time: was reported in five studies [12, 13, 16, 18, 20]. However, we were able to pool the results of four studies [12, 13, 16, 20] due to incomplete data from the fifth study. No significant heterogeneity was detected (I^2 = 41.33%, P = 0.164), using the fixed-effect model for analysis. The mean operation time ranged from 120 to 155.2 minutes, with the pooled estimate being 123.7 (95% CI: 116.58–130.89). The result was statistically significant (Z = 33.91, P = 0.000). Details of operation time in included studies are shown in (Table 2).

3-Blood loss: was reported in six studies [12, 13, 16-18, 20]. However, we were able to pool the results of five studies [12, 13, 16, 17, 20] due to incomplete data from the sixth study. We used the random effect model for analysis as significant heterogeneity was detected (I^2 = 91.52%, P = 0.000). The mean amount of blood loss ranged from 283 to 1436.9 ml, with the pooled estimate being 491.9 (95% CI: 347.01–636.77). The result was statistically significant (Z = 6.66, P = 0.000). Details of blood loss in included studies are shown in (Table 2).

Functional outcomes (Figure 2):

Functional outcomes of the hip were reported in eight studies [11-13, 15, 16, 18-20], but the assessment methods used were different. The Harris Hip Score (HHS) was used in three studies [18-20], in six studies [11-13, 15, 16, 19] Merle d'Aubigne-Postel score was used, Thompson–Epstein scale was used in three studies [11-13], and the Oxford Hip Score was used in one study [15]. In the current meta-analysis, a satisfactory functional outcome was defined as HHS or Merle d'Aubigne-Postel score graded as excellent or good. No significant heterogeneity was detected (I^2 = 0%, P = 0.893), using the fixed-effect model for analysis. The event rates of satisfactory outcome ranged from 0.62 to 0.98, with the pooled estimate being 0.85 (95% CI: 0.77-0.91). The result was

statistically significant (Z = 6.55, P = 0.000). According to individual assessment score or scale, excellent or good results were obtained in 87.9% (29 of 33 hips), 87.1% (88 of 101 hips), 83.3% (30 of 36 hips) according to HHS, Merle d'Aubigne-Postel score, and Thompson–Epstein scale, respectively.

Radiological outcome (Figure 3):

Four studies [15, 16, 19, 20] reported radiological outcomes in terms of obtaining fracture anatomical reduction. No significant heterogeneity was detected (I^2 = 49.66%, P = 0.114), using the fixed-effect model for analysis. The overall incidence of anatomic reduction ranged from 0.30 to 0.86, with the pooled estimate being 0.74 (95% CI: 0.61–0.83). The result was statistically insignificant (Z = 3.37, P = 0.001).

Complication rate (Figure 4):

All nine studies [11-13, 15-20] reported on the postoperative complications, namely avascular necrosis (AVN) of the femoral head, heterotopic ossification (HO) formation, posttraumatic osteoarthritis (OA), deep infection, trochanteric bursitis, and nonunion of the TFO. No significant heterogeneity was detected (I^2 = 11.18%, P = 0.342), using the fixed-effect model for analysis. The overall incidence of postoperative complications ranged from 0.30 to 0.86, with the pooled estimate being 0.44 (95% CI: 0.35–0.53). The result was statistically insignificant (Z = -1.27, P = 0.205) (Figure 4A).

1-AVN of the femoral head (Figure 4B): AVN was reported in all nine studies [11-13, 15-20]. No significant heterogeneity was detected (I^2 = 0%, P = 0.509), using the fixed-effect model for analysis. The incidence of AVN ranged from 0.02 to 0.33, with the pooled estimate being 0.12 (95% CI: 0.07–0.21). The result was statistically significant (Z = -6.32, P = 0.000).

2-HO formation (Figure 4C): HO was reported in eight studies [11-13, 15-17, 19, 20]. No significant heterogeneity was detected (I^2 = 0%, P = 0.798), using the

fixed-effect model for analysis. The incidence of HO ranged from 0.14 to 0.33, with the pooled estimate being 0.25 (95% CI: 0.18–0.34). The result was statistically significant (Z = -5.12, P = 0.000). According to the Brooker classification system [21], there was grade I in ten (33.3%) patients, grade II in 13 (43.3%), grade III in six (20%), and grade IV in one (3.4%). Excision was required in three (10%) patients.

3-Posttraumatic OA (Figure 4D): OA was reported in five studies [11, 15, 17, 19, 20]. We used the random effect model for analysis as significant heterogeneity was detected (I^2 = 71.82%, P = 6.696). The incidence of OA ranged from 0.04 to 0.86, with the pooled estimate being 0.16 (95% CI: 0.04–0.47). The result was statistically significant (Z = -2.12, P = 0.034).

4-Other complications: Further complications which were not included in the metanalysis were presented as follows, nonunion of the TFO was reported in five studies [11, 13, 15, 16, 19], and occurred at an incidence of 3.4% (three out of 89 hips), presence of infection was reported in six studies [13-17, 19], occurred at an incidence of 2.1% (two out of 97 hips), trochanteric bursitis was reported in one study [15] which occurred at an incidence of 3.8% (one out of 26 hips).

Reoperation rate (Figure 5):

Reoperation rate was reported in eight studies [11-13, 15-17, 19, 20]. No significant heterogeneity was detected (I^2 = 36.16%, P = 0.140), using the fixed effect model for analysis. The event rate for reoperation ranged from 0.08 to 0.57, with the pooled estimate being 0.20 (95% CI: 0.13–0.29). The result was statistically significant (Z = -5.53, P = 0.000), details of the reoperations required in (Table 3).

Discussion:

Femoral head fractures possess a challenge to the trauma surgeon, owing to the lack of a standard protocol for management and the various controversial issues around the best management option, the surgeon has to choose between conservative and surgical management if the latter was chosen, will it be excision or ORIF and through which approach it would be carried out [16, 22, 23]. Various surgical approaches have been utilized, including medial (Ludloff), anterior Smith-Petersen (S-P), posterior Kocher-Langenbeck (K-L), anterolateral (Watson-Jones) approaches, and even hip arthroscopy was reported to be a way of management; SHD has emerged in the past few years and gained popularity as an option to approach and treat FHFs [2, 3, 6, 24].

The most important findings in the current systematic review and metanalysis are that a large percentage of patients with FHFs obtained proper postoperative hip joint function after being managed through SHD; this approach enabled the surgeon to achieve anatomical fracture reduction and an acceptable rate of postoperative complications mainly femoral head AVN, HO formation, and posttraumatic OA development.

In the systematic review by Giannoudis et al., the data regarding the surgical approaches were collected from 14 articles forming 177 surgical cases and was distributed as follows; the K-L was the most commonly used in 72 (40.7%) cases, followed by the S-P in 44 (24.9%), in the third place was the SHD through TFO which was used in 36 (20.3%), the remaining were other approaches reported in fewer numbers (lateral, anterolateral, medial, and dual approach), 36 FHFs treated through SHD, which was driven from four studies [2], while in the current systematic review, we included data of 129 FHFs from nine studies, meaning that in the past ten years, the cases treated through SHD nearly tripled, indicating that this approach is gaining popularity among trauma surgeons.

Surgical data:

In the current systematic review, the reported average operative time was 123.7 minutes, which is considered[70] to be shorter than the operative time reported with the K-L approach but longer[71] than the S-P, as in a study by Wang et al. the authors compared managing Pipkin type I and II FHFs[2] (21 through S-P and 18 through K-L), the average operative time for the S-P approach group was 96.9 ± 14.8 minutes which was significantly shorter than the K-L approach group where the average operative time was 131.8 ± 21.2 minutes ($P < 0.001$) [25]. Many factors could affect the operative time, such as the presence of a concomitant injury that needs further management, such as an acetabular fracture (which was present in the current systematic review in 37.4% of the patients), or the presence of intra-articular injuries, mainly labral and head impaction injuries which were reported[72] in the current systematic review in 41.3% and 23.5% of patients, respectively. Another factor that might play a role; however, we were unable to assess is the surgical skill and familiarity of the surgeon with the SHD approach and the learning curve needed to master managing such injuries through SHD.[73]

The relatively prolonged operative time and the presence of associated injuries led to an increase in the blood loss, as the reported average blood loss in the current systematic review was 491.9 ml, with a maximum blood loss of 1436.9 ml as reported in one study [14], in Wang et al. study the average blood loss was lower in both approaches than what was reported[74] with SHD in the current review, and the[75] S-P approach group was even significantly lower than the K-L group, 103.3 ± 28.5 versus 334.5 ± 58.9, respectively ($p < 0.001$) [25].

Many fixation devices could be used[76] when ORIF is decided, such as headless subchondral screws, countersinking lag screws, bioabsorbable pins or screws, and suture fixation [15, 26-28]. The same diversity was reported in the current

systematic review, as various implants were used for fracture fixation, as reported in (Table 1). Some of the fixation devices had been criticized for causing foreign body reactions such as biodegradable screws or pins [27]; metal implants may lead to stress shielding besides causing an allergic reaction in susceptible patients [29].

Functional outcomes:

Although there was diversity in reporting the functional outcomes among the studies included in this metanalysis owing to implementing different assessment scales and scores, however, an overall satisfactory functional outcome (defined as excellent or good according to HHS or Merle d'Aubigne-Postel) was reported in 85% of the patients. Giannoudis et al. studied the relation between the functional outcomes and the utilized approach in 119 cases from nine studies, excellent and good results according to the Thompson–Epstein scale was reported in 83.4% of patients treated through SHD compared to 65.4% and 49% in patients who received S-P or K-L approaches respectively [2]. In the current systematic review, we found nearly the same result as 83.3% of the patients where the Thompson–Epstein scale was used for functional assessment reported being excellent or good. However, the functional results obtained in patients treated through SHD were better than what was reported in other studies using the K-L or S-P approaches; in a study by Del Core et al., they retrospectively reviewed the results of 22 patient managed for FHFs (five Pipkin I, three Pipkin II, 0 Pipkin III, and 14 Pipkin IV), surgical intervention was needed in 18 (82%) patients; S-P approach was used in 5 (28%) patients and K-L approach in 13 (72%). Overall functional results (regardless of the approach used) according to the Thompson and Epstein scale were excellent and good in 12 (54%) patients, fair and poor in ten (46%) [30]. In a systematic review and meta-analysis carried by Wang et al. comparing the S-

P versus K-L approaches for managing Pipkin type I and II fractures, five case-control trials were evaluated, including data of 68 patients (34 in each approach). An acceptable hip function (Excellent or good) according to Thompson and Epstein scale was achieved in 67.6% (23/34) treated through the S-P approach, and this was not different from the K-L approach (P = 0.82) [22].

Radiological outcomes:

There is no agreement on a scale or specific criteria to assess the quality of FHFs reduction (as what is to be considered as non-anatomical or mal-reduction) in the postoperative and follow up radiographs, which makes comparison across studies difficult; however, Masse et al. [14] was the first to describe using the Matta criteria [31] (originally described for acetabular fracture quality of reduction assessment) and applied it to the FHFs, in the current systematic review, a postoperative anatomic reduction was reported in about 74% of the patients reported from four studies, three of them [14, 16, 19] reported using the Matta criteria while in the fourth study by Gavaskar et al. [15] the authors did not report specific method of assessment. As the SHD allows for 360 degrees of head exposure, it is postulated that it will allow a better anatomical reduction of the fracture compared with the limited visualization offered by other approaches [7].

Complications:

The three major reported complications after FHFs management had been alternating between AVN of the femoral head, HO formation, and posttraumatic OA as reported in many studies regardless of the approach used for surgery [1-3, 26]. Controversy exists as to whether the trauma incident itself or the surgical intervention (including the surgical approach) is the cause leading to these complications; for example, the timing of reduction (if the patient

presented with a dislocated hip) could affect the complication incidence [8, 11, 32], and disruption of the femoral head vascularity (leading to AVN) can occur at the time of trauma rather than being a consequence of surgical intervention [33].

The overall incidence of postoperative complications in the current systematic review was 44%; however, only half of those patients needed further intervention. This incidence was higher than what was reported[94] in the initial series by Ganz et al. (treating non-traumatic conditions), where they reported a major[95] complication rate of 3.3% in 213 patients [7]. However, the incidence was lower than the overall complications reported in the Giannoudis et al. systematic review, where the major three complications were reported[96] to occur at an incidence of 68%, which reached 84.4% when cases treated through SHD were excluded [2].

AVN of the femoral head:

Ganz et al. reported 0% of AVN in their study; however, the cases they reported were non-traumatic conditions, but the authors proved the safety of SHD as regards[97] hip vascularity preservation [7]. In the systematic review by Giannoudis et al., after a mean follow-up of 59.7 months, AVN was reported in two (5.3%) out of 38 patients treated through the S-P approach, three (8.3%) out of 36 patients treated through SHD, and 11 (16.9%) patients out of 65 treated through K-L approach. The authors reported that the chance of a patient to develop AVN when treated through a K-L approach was 3.67 and 2.24 times higher compared to S-P or SHD approach, respectively ($p > 0.05$) [2]. In the current systematic review, we reported an incidence of AVN of 12 %, which was better than the K-L approach and higher than the S-P approach, as reported in the previous study. The same previous finding was confirmed in further studies as follows, in a study by Scolaro et al. on 147 FHFs classified according to

Pipkin classification into type I (27%), II (42%), III (4.7%), IV in (15%); and (10%) as others which included impaction injuries. ORIF was performed in 78 (53.1%) fractures; 97% of these were approached through the S–P approach; after a mean follow up of 12.4 months, six (8.7%) patients developed AVN, mostly all Pipkin III fractures (n = 5) had AVN [1]. In a study by Stannard et al. where they surgically treated 17 patients diagnosed with FHFs, in six patients (35%) S-P approach was used, 10 (59%) underwent K-L approach, and one (6%) underwent dual anterior and posterior approaches, the authors reported that four of the five patients who had AVN were managed through K-L approach, they reported that the odds ratio was 3.2 times higher rate of AVN when K-L approach was used compared to the S-P approach [34]. In a retrospective analysis by Swiontkowski et al. of 24 patients presented with Pipkin types I and II (12 patients were treated through the K-L approach and 12 through the S-P approach), the authors reported an incidence of AVN of 16.7% with the K-L approach compared to 0% when the surgery was performed through the S-P approach [35]. In the systematic review by Guo et al., they included studies from 1980 to April 2009 to evaluate the relation of the surgical approach to the development of AVN; ten studies were eligible to be included with a total of 176 cases, the incidence of AVN was more with the K-L approach (16.9%) than the S-P (7.9%), however, the difference was not significant [36].

HO formation:

It is not clearly defined if HO formation relates to the surgical approach or the traumatic muscle injury [26], and the exact pathogenesis is still unclear, but other factors rather than the type of the approach had been accused such as being a polytrauma patient, concomitant craniocerebral or thoracoabdominal trauma, male sex, the time to hip reduction (if dislocated), delay to surgery, and associated fractures as in type III and IV injuries [37-39]. In the current

systematic review, SHD was associated[105] with HO[2] formation at an incidence of 25%; surprisingly, this incidence was lower than the incidence reported with treating non-traumatic conditions as Ganz et al. reported 37% of their patients having HO[2] formation, and in another study by Kargin et al. where they evaluated 44 patients underwent SHD for non-traumatic causes, with a mean follow up of 66 months, they reported an incidence of HO[2] formation of 36.5% [40]. The incidence reported in the current systematic review was lower than what was reported by Giannoudis et al., as they noted that HO[2] of any grade occurred in 44.7% of patients treated with the S-P approach and in 32.3% of patients treated through the K-L approach; however, the difference between approaches was not significant (p. 0.05), The authors reported an incidence of 47.2% in the patients treated through SHD included in their review (which is nearly double the incidence in the current review), they estimated a 1.87 times higher rate of HO[2] following SHD; however, they noted that this higher incidence did not affect the functional outcomes [2]. In the systematic review by Guo et al., HO[2] formation was lower in the SHD group (33.3%) compared to the S-P or K-L approaches (42.1% and 36.9%), although the difference was not statistically significant [36]. In a study by Peng et al. reporting their results of treating FHFs[2] at an average follow up of 3.3 years, 18 patients treated through the S-P approach, and six through the K-L approach, the overall incidence of HO[2] was 43%, and no surgical intervention was needed [41]. In the current systematic review, lower grades HO[2] (Brooker I and II) occurred in 76.5 % of the patients, while higher grades (III and IV) occurred in 23.4 %, this was nearly similar to the results obtained from the study by Scolaro et al., where low-grade HO[2] developed in 74% of the patients, while higher grades developed in 24%, however, they had a lower incidence of surgical intervention for HO[2] in only 2.9% of patients who required surgical excision [1], compared to 10% of the patients

in the current systematic review. The lower incidence of HO formation in the current systematic review compared to the previous reports may be attributed to the advancement in HO prophylaxis techniques, more orientation about the problem which was gained from previous studies, and it could be due to increasing experience of surgeons with the SHD technique paying more respect to soft tissues.

Posttraumatic OA:

This complication could develop due to improper fracture reduction, or as a consequence of AVN, as in some studies, the authors reported AVN and OA as a single entity [1]. In the current systematic review, we reported an incidence of posttraumatic OA of 16% after SHD, which is considered higher than the incidence reported with cases managed through SHD in the Giannoudis et al. systematic review, where the authors reported 0% incidence; however, the incidence reported with SHD still lower than other approaches, as Giannoudis et al. reported an incidence of 21% and 29.2% in patients treated through the S-P and K-L approaches, respectively. They estimated a 20.3 ($p = 0.04$) and 30.6 ($p = 0.018$) times higher incidence of posttraumatic OA development when the S-P or K-L approach was used, respectively, compared to SHD [2]. An increased incidence with other approaches was reported in other studies, as in the study by Wang et al. the authors reported a posttraumatic OA incidence of 14.3% and 16.7% with the S-P and K-L approaches, respectively the difference was insignificant ($p = 1.000$). Del Core et al. reported an overall incidence of 23% in their patients [30]. In the current systematic review, the increased incidence of OA development could be attributed to the fact that six of the 12 patients who developed posttraumatic OA were reported from Engel et al. study [17], where all the included cases were Pipkin type IV with an incidence of OA of 85.7% (six

out of seven patients), owing to the severity and complexity of this type of injury.

Infection:

This was the lowest reported complication in the current systematic review, which occurred at an incidence of 2.1%, and only two patients required further surgical intervention; this was in accordance with previous studies, as in the systematic review by Giannoudis et al. the incidence of infection was 3.2% [2]. In the study by Del Core et al., One patient (5%) developed a postoperative infection [30]. In a study by Peng et al., no deep infection was reported [41].

SHD unique complications:

The possibility of TFO nonunion, and the development of trochanteric bursitis with lateral thigh pain secondary to irritation by the screws used to fix the TFO, are unique complications to the SHD approach [7, 13, 42, 43]. An incidence of TFO nonunion was reported in five studies in the current review giving an incidence of 3.4%, and two patients required refixation. The incidence was even lower in the studies reported on non-traumatic conditions, as in a multicenter study by Sink et al., they evaluated 334 hips from different eight North American centers with a minimum of 12 months follow up, TFO nonunion was reported in six hips (1.8%), all united after revision the internal fixation [44]. Ganz et al. reported three (1.4%) cases with TFO nonunion [7]. In the current systematic review, we reported an incidence of trochanteric bursitis with lateral thigh pain in one (3.8%) patient out of 26 hips, which required screw removal. In the study by Kargin et al., lateral thigh pain was reported to occur in 28.8% of their patients [40].

Advantages of the SHD approach:

Trauma surgeons were encouraged to incorporate the SHD in the management of FHFs as it offered many advantages. Firstly, the wide exposure (360 degrees)

of both the femoral head and the acetabulum making it possible to treat both pathologies if present (as in pipkin type 4) at the same time. Secondly, it enables the detection and dealing with other intraarticular injuries such as labrum injury or head impaction injuries which may be difficult to diagnose in preoperative imaging studies [45-47]. Thirdly, the ability of the approach to allow the surgeon for better reduction and fixation of the fractured fragments. Lastly, the ability to check the vascularity of the femoral head intraoperatively by using the drill test (Figure 1) [7, 8].

Limitations of the current systematic review:

First, we did not compare the results obtained from SHD with other approaches, which might be due to the lack of comparative studies in this field. Second, one crucial point that was not assessed[117] is the experience of the surgeon with this approach, some authors reported having no familiarity with this approach [41], on the other hand, in two studies [14, 19] included in the metanalysis, the authors reported having previous experience with SHD approach; however, we found it unmeasurable and challenging to state the learning curve needed to master this technique. Lastly, limiting the article search to the past 20 years might lead to missing some earlier articles; however, we aimed at presenting as updated data as possible.

Conclusion:

Incorporating SHD as an optional approach in the armamentarium of approaches in dealing with FHFs[2] enables trauma surgeons to properly manage these intraarticular fractures, detect and deal with additional intraarticular injuries. It offered acceptable functional and radiological outcomes with a wide range of safety as regards the hip joint vascularity and the development of AVN, the formation of HO[2], and the development of posttraumatic OA[2]; however, it still

carries its unique risk of complications such as TFO nonunion and persistent lateral thigh pain.

Article Highlights:

(1) Research background: Surgical hip dislocation (SHD) was introduced as a safe approach for managing various hip pathologies; however, it gained popularity among trauma surgeons as a new approach for the management of femoral head fractures (FHFs). Several studies were published on this subject; however, no systematic reviews were carried pooling these data together to generate stronger evidence of this approach utility.

(2) Research motivation: FHFs are considered as intraarticular fracture, anatomical reduction and preservation of its vascularity are two mandatory perquisites for obtaining optimum outcomes; SHD was introduced for the management of these fractures with the advantage of preserving femoral head vascularity and providing 360 degrees visualization of the femoral head.

(3) Research objectives: We carried this systematic review and meta-analysis to evaluate the efficacy (functional and radiological outcomes) as well as the safety (complications incidence) of using the SHD approach for management of FHFs which could help encourage more surgeon to widely adopting this approach in their practice.

(4) Research methods: Four major databases were searched (PubMed, Embase, Web of Science, and CENTRAL) to collect eligible studies reporting on various outcomes (functional, radiological, and complications) after utilizing SHD as described by Ganz in the management of FHFs. Articles basic, surgical, functional, radiographic, and complications data were collected from the included articles.

(5) Research results: Nine studies were eligible and included in the analysis, forming a total of 129 FHFs with an average follow up of 38.4 months; the average operative time and blood loss were 123.74 minutes and 491.89 ml respectively. Excellent and good functional outcomes were obtained in 85% of the patients, while anatomical fracture reduction could be obtained in 74%. The overall complication rate was 44%; the main reported complications were femoral head avascular necrosis (AVN), heterotopic ossification (HO), and osteoarthritis (OA) which occurred at an incidence of 12%, 25%, and 16% respectively. A unique complication to SHD was Trochanteric flip osteotomy (TFO) nonunion and trochanteric bursitis which occurred at an incidence of 3.4% and 3.8% respectively. The issue of surgeon experience and its relation to the results and utilization of this approach is still to be studied.

(6) Research conclusions: We believe that this was the most recent systematic review collecting and reporting the data regarding the efficacy and safety of SHD as an approach for management of FHFs; the results of this systematic review suggests the high safety profile of this approach with acceptable functional outcomes.

(7) Research perspectives: We believe that there is a need for further studies and systematic reviews comparing the SHD approach to conventional approaches (anterior and posterior) in the management of FHFs to prove its safety and efficacy.

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Footnotes:

Conflict-of-interest statement: The authors deny any conflict of interest.

PRISMA 2009 Checklist statement: We admit that the guidelines of the PRISMA 2009 Statement have been adopted for preparation of the manuscript.

Figure Legends:

Figure 1: PRISMA flow diagram of search results, studies' screening, and selection.

Figure 2: Forest plot diagram shows postoperative functional outcomes.

Figure 3: Forest plot diagram shows postoperative anatomical reduction as a representative of radiological outcomes.

Figure 4: Forest plot diagram shows postoperative complications. A, overall complications incidence. B, AVN of the femoral head. C, HO formation. D, Posttraumatic OA. (AVN: avascular necrosis; HO: heterotopic ossification; OA: osteoarthritis).

Figure 5: Forest plot diagram shows postoperative reoperation rate.

Tables captions:

Table 1: Baseline characteristics of included studies

Author, year

Study design

Sample size

Age*, years

Sex

Pipkin classification

(I/II/III/IV)

Management

Implant

Follow up*, months

M

F

Fixation

Excision

1-Henle, 2007 [11]

Retrospective

12

39.8 (26-71)

10

2

1/3/0/8

12

0

Mini or small fragment cortical screws (2.0—2.7 mm) or Herbert screws or absorbable pins

31.1 (3-96)

2-Solberg, 2009 [12]

Retrospective

12

-

10

2

0/0/0/12

11

1

Headless variable-pitch screws or Herbert screws.[174]

47 (24-71)

3-Mostafa, 2014 [13]

Retrospective

12

-

-

-

12/0/0

12

0

Partially threaded cancellous screws or Herbert headless screws

31 (24-84)

4-Masse, 2015 [14]

Retrospective

13

34

(22-54)

11

2

5/2/0/6

13

0

2.7 mm nonabsorbable screws

77 (26-122)

5-Gavaskar, 2015 [15]

Prospective

28

-

-

-

6/22/0/0

26

2

2.4 mm headless screws (Synthes—India).

36 (25-46)

6-Wang, 2019 [16]

Prospective

12

39.9 ± 12.2

8

4

4/3/0/5

12

0

3.2 mm Herbert screws or partially threaded screws

35 (25-48)

7-Engel, 2020 [17]

Retrospective

7

39.57 (17-64)

4

3

0/0/0/7

6

1

Buried headless screw

29.8 (11.6-67.2)

8-Rana, 2020 [18]

Retrospective

6

42

(32-54)

4

2

-

6

0

Herbert (headless) screw

10.8 (8-18)

9-Khalifa, 2020 [19]

Retrospective

27

33.8 (18-45)

21

6

6/13/0/8

27

0

4 mm partially threaded cancellous screws or Herbert headless screws

48 (24-72)

* Data are presented as mean ± SD[2] or mean (range). M: male; F: female; mm: millimeter

Table 2: Operation time and blood loss (six studies)

Author, year

Operation time

Blood loss

Solberg, 2009 [12]

121 ± 28.3 (102-215)

350 ± 125 (250-750)

Mostafa, 2014 [13]

120 ± 19.7

283 ± 124.9

Masse, 2015 [14]

155.2 ± 53.1

1436.9 ± 663.8

Wang, 2019 [16]

124.2 ± 22.1

437.5 ± 113.1

Engel, 2020 [17]

NR

503 ± 181.25

Rana, 2020 [18]

90

450

NR: not reported

Table 3: Details of reoperation (eight studies)

Author, year

Indication of reoperation

Intervention

Henle, 2007 [11]

2 AVN

2 HO

THA

Excision

Solberg, 2009 [12]

1 AVN

THA

Mostafa, 2014 [13]

1 AVN

1 TFO[2] Nonunion

THA[2]

Revision of fixation

Masse, 2015 [14]

1 AVN

1 OA

THA

THA

Gavaskar, 2015 [15]

1 Infection

1 Bursitis

Debridement

Screw removal

Wang, 2019 [16]

1 AVN

1 HO[2]

1 TFO[2] Nonunion

THA[2]

Excision

Revision of fixation

Engel, 2020 [17]

2 OA/ AVN

1 OA/HO

1 OA[2]/Metal failure/Infection

THA

THA

Revision/Girdlestone/THA[2]

Khalifa, 2020 [19]

2 AVN

1 OA

THA

THA

AVN [175]: avascular necrosis; HO[2]: heterotopic ossification; THA[2]: total hip arthroplasty; OA: osteoarthritis; TFO[2]: trochanteric flip osteotomy

1.	*journal; Journal*	Text inconsistencies	Correctness
2.	*FHFs; M.D.; A.A.K.; M.A.H.; A.F.; MDs; CIs; HO; OA; TFO; THA; USA; HHS; EL; MRI; SD*	Text inconsistencies	Correctness
3.	*All authors discussed the results and commented on the manuscript. All authors read and approved the final manuscript and are responsible for the content and similarity index of the manuscript.*	Unclear paragraphs	Clarity
4.	*been adopted*	Passive voice misuse	Clarity
5.	*are preferred*	Passive voice misuse	Clarity
6.	*been utilized*	Passive voice misuse	Clarity
7.	*were searched*	Passive voice misuse	Clarity
8.	*was achieved*	Passive voice misuse	Clarity
9.	, respectively	Punctuation in compound/complex sentences	Correctness
10.	~~as~~ → is	Confused words	Correctness
11.	, respectively	Punctuation in compound/complex sentences	Correctness
12.	the SHD	Determiner use (a/an/the/this, etc.)	Correctness
13.	~~management~~ → manage	Confused words	Correctness
14.	~~as regards~~ → regarding	Wordy sentences	Clarity
15.	*been adopted*	Passive voice misuse	Clarity
16.	, such	Punctuation in	Correctness

		compound/complex sentences	
17.	*were identified*	Passive voice misuse	Clarity
18.	*is kept*	Passive voice misuse	Clarity
19.	*be offered*	Passive voice misuse	Clarity
20.	*was initially described*	Passive voice misuse	Clarity
21.	~~large~~ → extensive, significant	Word choice	Engagement
22.	~~larger~~ → more significant	Word choice	Engagement
23.	~~carry~~ → take	Incorrect phrasing	Correctness
24.	*We conducted a systematic review according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [9]. PubMed, Embase, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) databases were searched for the last 20 years (till January 2021)...*	Unclear paragraphs	Clarity
25.	*were imported*	Passive voice misuse	Clarity
26.	*was conducted*	Passive voice misuse	Clarity
27.	*were then screened*	Passive voice misuse	Clarity
28.	*was based*	Passive voice misuse	Clarity
29.	*Articles published in languages other than English.*	Incomplete sentences	Correctness
30.	*be extracted*	Passive voice misuse	Clarity
31.	*A minimum sample size of 5 patients.*	Incomplete sentences	Correctness
32.	*The ability to extract data related to the*	Incomplete sentences	Correctness

	outcomes of interest (data should be genuine and not reported in another study).		
33.	*was consulted*	Passive voice misuse	Clarity
34.	*was extracted*	Passive voice misuse	Clarity
35.	*was calculated*	Passive voice misuse	Clarity
36.	*was chosen*	Passive voice misuse	Clarity
37.	*was evaluated*	Passive voice misuse	Clarity
38.	~~percentage of~~	Wordy sentences	Clarity
39.	*were excluded*	Passive voice misuse	Clarity
40.	*be extracted*	Passive voice misuse	Clarity
41.	*After excluding 192 duplicates, 810 records remained for a title and abstract screening. We had 18 relevant articles for full-text screening, eight fulfilled the inclusion criteria, and ten were excluded (one article not in English, six articles were case reports or included less than five cases, t...*	Unclear paragraphs	Clarity
42.	*were ultimately included*	Passive voice misuse	Clarity
43.	*The manual search of the included articles references imported one additional article. Nine studies [11-19] were ultimately included in the qualitative and quantitative analyses.*	Unclear paragraphs	Clarity
44.	*is shown*	Passive voice misuse	Clarity
45.	~~basic~~ → primary	Word choice	Engagement
46.	*were extracted*	Passive voice misuse	Clarity
47.	*were extracted*	Passive voice misuse	Clarity

48.	*was not reported*	Passive voice misuse	Clarity
49.	*are summarized*	Passive voice misuse	Clarity
50.	*was reported*	Passive voice misuse	Clarity
51.	*were reported*	Passive voice misuse	Clarity
52.	*was used*	Passive voice misuse	Clarity
53.	*was used*	Passive voice misuse	Clarity
54.	*was defined*	Passive voice misuse	Clarity
55.	*In the current meta-analysis, a satisfactory functional outcome was defined as HHS or Merle d'Aubigne-Postel score graded as excellent or good.*	Unclear sentences	Clarity
56.	*were obtained*	Passive voice misuse	Clarity
57.	~~in terms of obtaining~~ → to obtain	Wordy sentences	Clarity
58.	anatomical fracture	Misplaced words or phrases	Correctness
59.	*was reported*	Passive voice misuse	Clarity
60.	*were not included*	Passive voice misuse	Clarity
61.	*were presented*	Passive voice misuse	Clarity
62.	*was reported*	Passive voice misuse	Clarity
63.	*was reported*	Passive voice misuse	Clarity
64.	*was chosen*	Passive voice misuse	Clarity
65.	*was reported*	Passive voice misuse	Clarity
66.	*were collected*	Passive voice misuse	Clarity

67.	*was distributed*	Passive voice misuse	Clarity
68.	*was used*	Passive voice misuse	Clarity
69.	~~, while~~ → . In contrast,	Hard-to-read text	Clarity
70.	*is considered*	Passive voice misuse	Clarity
71.	~~but longer~~ → . However, longer	Hard-to-read text	Clarity
72.	*were reported*	Passive voice misuse	Clarity
73.	*Another factor that might play a role; however, we were unable to assess is the surgical skill and familiarity of the surgeon with the SHD approach and the learning curve needed to master managing such injuries through SHD.*	Unclear sentences	Clarity
74.	*was reported*	Passive voice misuse	Clarity
75.	~~, and the~~ → . The	Hard-to-read text	Clarity
76.	*be used*	Passive voice misuse	Clarity
77.	*been criticized*	Passive voice misuse	Clarity
78.	*The same diversity was reported in the current systematic review, as various implants were used for fracture fixation, as reported in (Table 1). Some of the fixation devices had been criticized for causing foreign body reactions such as biodegradable screws or pins [27]; metal implants may lead to ...*	Unclear paragraphs	Clarity
79.	*Although there was diversity in reporting the functional outcomes among the studies included in this metanalysis owing to implementing different assessment scales and scores, however, an overall satisfactory functional outcome (defined as excellent or good*	Unclear sentences	Clarity

	according to HHS or Merle d'Aubigne-Postel...		
80.	~~excellent and good~~ → excellent	Wordy sentences	Clarity
81.	*was reported*	Passive voice misuse	Clarity
82.	*was used*	Passive voice misuse	Clarity
83.	*was needed*	Passive voice misuse	Clarity
84.	*was used*	Passive voice misuse	Clarity
85.	~~excellent and good~~ → excellent	Wordy sentences	Clarity
86.	~~An acceptable~~ → A proper	Word choice	Engagement
87.	*was achieved*	Passive voice misuse	Clarity
88.	*be considered*	Passive voice misuse	Clarity
89.	described initially, initially described	Word choice	Engagement
90.	*was reported*	Passive voice misuse	Clarity
91.	*is postulated*	Passive voice misuse	Clarity
92.	~~compared with~~ → than	Wordy sentences	Clarity
93.	*There is no agreement on a scale or specific criteria to assess the quality of FHFs reduction (as what is to be considered as non-anatomical or mal-reduction) in the postoperative and follow up radiographs, which makes comparison across studies difficult; however, Masse et al. [14] was the first to...*	Unclear paragraphs	Clarity
94.	*was reported*	Passive voice misuse	Clarity
95.	~~major~~ → significant	Word choice	Engagement

96.	*were reported*	Passive voice misuse	Clarity
97.	~~as regards~~ → regarding	Wordy sentences	Clarity
98.	~~was performed~~ → has performed	Incorrect verb forms	Correctness
99.	*were approached*	Passive voice misuse	Clarity
100.	*was used*	Passive voice misuse	Clarity
101.	*were managed*	Passive voice misuse	Clarity
102.	*were treated*	Passive voice misuse	Clarity
103.	*was performed*	Passive voice misuse	Clarity
104.	~~, but other~~ → . However, other	Hard-to-read text	Clarity
105.	*was associated*	Passive voice misuse	Clarity
106.	*In the current systematic review, lower grades HO (Brooker I and II) occurred in 76.5 % of the patients, while higher grades (III and IV) occurred in 23.4 %, this was nearly similar to the results obtained from the study by Scolaro et al., where low-grade HO developed in 74% of the patients, while high...*	Hard-to-read text	Clarity
107.	*was gained*	Passive voice misuse	Clarity
108.	~~the difference~~	Wordy sentences	Clarity
109.	*An increased incidence with other approaches was reported in other studies, as in the study by Wang et al. the authors reported a posttraumatic OA incidence of 14.3% and 16.7% with the S-P and K-L approaches, respectively the difference was insignificant (p = 1.000). Del Core et al. reported an ove...*	Unclear paragraphs	Clarity
110.	*be attributed*	Passive voice misuse	Clarity

111.	*were reported*	Passive voice misuse	Clarity
112.	*This*	Intricate text	Clarity
113.	~~in accordance with~~ → by, following, per, under	Wordy sentences	Clarity
114.	*was reported*	Passive voice misuse	Clarity
115.	*was reported*	Passive voice misuse	Clarity
116.	~~wide~~ → broad	Word choice	Engagement
117.	*was not assessed*	Passive voice misuse	Clarity
118.	*was introduced*	Passive voice misuse	Clarity
119.	*were published*	Passive voice misuse	Clarity
120.	*were carried*	Passive voice misuse	Clarity
121.	~~stronger~~ → more substantial, more robust, more vital	Word choice	Engagement
122.	*are considered*	Passive voice misuse	Clarity
123.	*was introduced*	Passive voice misuse	Clarity
124.	~~carried~~ → took	Incorrect phrasing	Correctness
125.	, which	Punctuation in compound/complex sentences	Correctness
126.	~~major~~ → significant	Word choice	Engagement
127.	*were searched*	Passive voice misuse	Clarity
128.	*were collected*	Passive voice misuse	Clarity
129.	, respectively	Punctuation in	Correctness

		compound/complex sentences	
130.	~~Excellent and good~~ → Excellent	Wordy sentences	Clarity
131.	*be obtained*	Passive voice misuse	Clarity
132.	, which	Punctuation in compound/complex sentences	Correctness
133.	, respectively	Punctuation in compound/complex sentences	Correctness
134.	, respectively	Punctuation in compound/complex sentences	Correctness
135.	*The issue of surgeon experience and its relation to the results and utilization of this approach is still to be studied.*	Unclear sentences	Clarity
136.	~~suggests~~ → suggest	Faulty subject-verb agreement	Correctness
137.	~~great~~ → outstanding	Word choice	Engagement
138.	~~orthopaedics~~ → orthopedics	Mixed dialects of English	Correctness
139.	traumatology :	Improper formatting	Correctness
140.	the treatment	Determiner use (a/an/the/this, etc.)	Correctness
141.	*pmed*	Unknown words	Correctness
142.	a meta-analysis, or the meta-analysis	Determiner use (a/an/the/this, etc.)	Correctness
143.	*be recommended*	Passive voice misuse	Clarity
144.	The use	Determiner use	Correctness

		(a/an/the/this, etc.)	
145.	~~Alluto~~ → Auto	Misspelled words	Correctness
146.	the treatment	Determiner use (a/an/the/this, etc.)	Correctness
147.	~~treatment of~~ → treating	Wordy sentences	Clarity
148.	the treatment	Determiner use (a/an/the/this, etc.)	Correctness
149.	~~for treatment of~~ → to treat	Wordy sentences	Clarity
150.	literature review	Wordy sentences	Clarity
151.	the literature	Determiner use (a/an/the/this, etc.)	Correctness
152.	~~Alluto~~ → Auto	Misspelled words	Correctness
153.	the treatment	Determiner use (a/an/the/this, etc.)	Correctness
154.	~~treatment of~~ → treating	Wordy sentences	Clarity
155.	Arthroscopy :	Improper formatting	Correctness
156.	surgery :	Improper formatting	Correctness
157.	~~the treatment of~~ → treating	Wordy sentences	Clarity
158.	*blo*	Unknown words	Correctness
159.	~~Impact of~~ → The	Wordy sentences	Clarity
160.	~~the development of~~ → developing	Wordy sentences	Clarity
161.	~~xiu~~ → Xiu	Misspelled words	Correctness
162.	~~chong~~ → Chong	Misspelled words	Correctness

163.	~~jian~~ → Jian	Misspelled words	Correctness
164.	*ke*	Unknown words	Correctness
165.	~~zhi~~ → Zhi	Misspelled words	Correctness
166.	~~xiufu~~ → Xiu	Misspelled words	Correctness
167.	~~chongjian~~ → Chong Jian	Misspelled words	Correctness
168.	~~waike~~ → wake, wait, which	Misspelled words	Correctness
169.	~~zazhi~~ → za Zhi	Misspelled words	Correctness
170.	*Conflict-of-interest statement: The authors deny any conflict of interest.*	Incomplete sentences	Correctness
171.	*been adopted*	Passive voice misuse	Clarity
172.	the preparation	Determiner use (a/an/the/this, etc.)	Correctness
173.	A,	Comma misuse within clauses	Correctness
174.	*Headless variable-pitch screws or Herbert screws.*	Incomplete sentences	Correctness
175.	AVN :	Improper formatting	Correctness