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Advantages and disadvantages of using modular stems in revision hip arthroplasty

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The increasing number of revision hip surgeries highlights the challenge of selecting the optimal revision femoral component, particularly in cases of bone stock loss. Objective. To determine the advantages and disadvantages of modular revision stems compared to monoblock stems based on literature data and personal clinical observations. Methods. A literature review (37 sources) and a retrospective analysis of 175 revision surgeries performed between 2013 and 2025 were conducted. Patients were divided into two groups: 70 cases utilizing modular stems and 105 using monoblock stems. The study assessed the distribution of bone defects according to the Paprosky classification, complication rates, and functional outcomes using the Harris Hip Score (HHS) at 1-year follow-up. Results. Monoblock stems were predominantly used for Paprosky type I–II femoral defects (79 %), whereas modular stems were preferred for type III–IV defects (66.2 %). The overall complication rate was comparable: 8.8 % in the modular group and 8 % in the monoblock group (P = 0.834). Significant subsidence (> 10 mm) was more frequently observed with monoblock stems. Functional outcomes according to HHS significantly improved in both groups after one year (80.2 ± 3.1 and 83.1 ± 3.3 points, respectively) with no statistically significant difference between them. Conclusions. The clinical outcomes of modular and monoblock stems are equivalent. The choice of implant should be based on the anatomical situation: monoblock stems are effective for moderate defects, while modular stems offer advantages in severe defects (Paprosky type III–IV) to ensure stable fixation and biomechanical restoration.

Зростання кількості ревізійних втручань на кульшовому суглобі актуалізує проблему вибору оптимального ревізійного стегнового компонента, особливо в умовах дефіциту кісткової тканини. Мета. Виявити переваги та недоліки модульних ревізійних ніжок у порівнянні з моноблочними на основі даних літературних джерел і власних клінічних спостережень. Методи. Проведено огляд публікацій (37 статей) та ретроспективний аналіз 175 ревізійних втручань, виконаних у період 2013–2025 р. Пацієнтів розподілено на дві групи: 70 випадків застосування модульних ніжок і 105 — моноблочних. Проаналізовано розподіл типів дефектів за Paprosky, частоту ускладнень і функціональні результати за шкалою Harris Hip Score (HHS) через рік після операції. Результати. У разі дефектів стегнової кістки за Paprosky I–II типу частіше застосовували моноблочні ніжки (79 %), тоді як за III–IV — переважали модульні (66,2 %). Загальна частота ускладнень була порівнянною: 8,8 % у групі модульних ніжок та 8 % за умов використання моноблочних (p = 0,834). Значне просідання (> 10 мм) частіше спостерігали під час використання моноблочних ніжок. Функціональні результати за HHS через рік суттєво покращилися в обох групах (80,2 ± 3,1 та (83,1 ± 3,3) бала відповідно) без статистично значущої різниці між ними. Висновки. Результати застосування модульних і моноблочних ніжок є клінічно рівнозначними. Вибір конструкції повинен ґрунтуватися на анатомічній ситуації: моноблочні ніжки доцільні в разі помірних дефектів, тоді як використання модульних мають переваги за значних дефектів (Paprosky III–IV) для забезпечення надійної фіксації та відновлення біомеханіки суглоба. Ключові слова. Ревізія кульшового суглоба, безцементні моноблочні ревізійні ніжки, безцементні модульні ревізійні ніжки кульшового суглоба, переваги та недоліки модульних ревізійних ніжок.

Keywords. Hip revision arthroplasty, monobloc revision uncemented stems, modular revision uncemented stems, advantages and failures of modular revision stems

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Introduction

Revision total hip arthroplasty involving replacement of the femoral stem usually requires the use of a revision stem to address bone loss. The choice of revision stem, from long modular and monoblock designs to short and primary stems, affects fixation, bone preservation, complication rates, and long-term outcomes.

Based on their design and indications for use in femoral component revision, stems can be classified into the following groups:

1. tapered, fluted, titanium (TFT) revision stems. Both modular and monoblock designs are widely used, with newer monoblock stems demonstrating reduced subsidence and promising clinical outcomes in the revision setting [1–6];

2. primary cementless and short revision stems: these are increasingly being considered for patients with Paprosky type I–II defects, offering bone preservation and facilitating future revisions [7–12];

3. cemented revision stems [8, 13].

The indications for the use of cemented revision stems are relatively limited. First, they are indicated in cases of poor bone quality: cemented stems are the preferred option for patients with compromised bone quality, such as older adults or patients with osteoporosis, in whom immediate implant stability is essential and cementless fixation may be unreliable [14, 15]. They are also indicated when the cement-in-cement technique is used, provided that the existing cement mantle is well fixed, allowing the new stem to be implanted into the existing mantle. This is particularly useful in cases of femoral component loosening, where removal of a well-fixed cement mantle may result in further bone loss [16, 17]. According to published data, cemented revision stems were used in only 7.4 % of cases, although they demonstrate favorable long-term survivorship [13]. In most cases, cementless stems, both modular and monoblock, are implanted, which is consistent with the experience of our clinic (approximately 8 % of revision stems are cemented). Primary cementless and short revision stems are also used, although infrequently. Surgeons generally favor the use of modular and monoblock revision stems.

Objective: to identify the advantages and disadvantages of modular revision stems for total hip arthroplasty compared with monoblock stems, based on published evidence and the clinical experience of the Department of Joint Pathology, Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Medical Sciences of Ukraine.

Materials and Methods

The study was approved by the local Bioethics Committee in accordance with the applicable legislation (Protocol No. 257, dated 22.12.2025). Written informed consent was obtained from all patients.

A literature review was conducted using the scientometric electronic databases PubMed, Scopus, Web of Science, and other relevant sources of scientific and medical information. The search was performed using the following keywords: hip revision arthroplasty, monobloc revision uncemented stems, modular revision uncemented stems, advantages and failures of modular revision stems.

The search covered the period from 1995 to 2025, allowing consideration of contemporary approaches to the use of modular and monoblock cementless revision stems. A total of 37 publications, including 7 systematic reviews, that met the relevance and completeness criteria for the research topic were included in the analysis. Twenty-seven of the included publications were published within the past 5 years.

In addition, the study incorporated the authors' own clinical experience with revision procedures using modular and monoblock revision stems for total hip arthroplasty. Between 2013 and 2025, a total of 175 revision procedures involving revision stems were performed at our institution. This made it possible to complement the theoretical evidence with practical observations and recommendations.

Articles were selected according to the following criteria: relevance to the study topic; level of evidence; reporting of clinical and radiographic outcomes; analysis of complications; and publication in peer-reviewed scientific journals.

Sources were excluded if they did not provide sufficient information on the technique of using modular or monoblock stems during revision total hip arthroplasty, lacked clinical evidence supporting the effectiveness of the described implants or techniques, or dealt exclusively with primary total hip arthroplasty or had an excessively short follow-up period.

Clinical data were analyzed to assess complications and outcomes following implantation of modular (70 cases) and monoblock (105 cases) stems during revision arthroplasty performed for aseptic loosening (86 cases), periprosthetic infection (64), periprosthetic fractures (12), dislocations (2), and stem fractures (11). One-year follow-up data were available for 68 cases in the modular stem group and 101 cases in

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the monoblock stem group. The distribution of patients by age and sex is presented in Table 1.

Data variability (SD) for the two groups was as follows: modular stems, standard deviation (s) = 10.69; monoblock stems, standard deviation (s) = 11.19. The t-statistic was 1.536, with a p-value of 0.1265. The mean age difference between the groups was 2.6 years (61.7 vs. 59.1 years), which was not statistically significant at the 5% significance level. This indicates that the age difference between patients receiving modular and monoblock stems does not reflect a true difference between the two underlying populations.

Results

Modular stems for revision total hip arthroplasty were developed in the 1990s [18, 19] and were used only to a limited extent until 1999. Their widespread adoption occurred during the period from 2000 to 2010 [20, 21].

The development of these stems was driven by the increasing number of primary total hip arthroplasties and, consequently, the growing incidence of complications requiring revision surgery. It soon became evident that, in most cases, removal of the primary stem resulted in a bone defect in the proximal femur, while the distal femoral canal remained relatively well preserved. The most widely used Paprosky classification of femoral bone defects comprises four types (Fig. 1).

In Paprosky type II–IV defects, standard stems do not provide stable fixation. Modular stems address this problem by achieving stable primary distal fixation and allowing selection of an appropriately sized proximal module to fill the bone defect in the proximal femur [22].

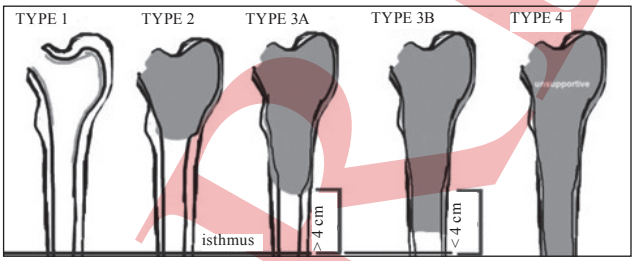


Fig. 1. Paprosky classification of femoral bone defects

Modular revision stems are better suited to patients' anatomical characteristics, enabling implant stability through reconstruction of bone defects, restoration of hip biomechanics, and correction of leg length.

Modularity plays a key role in achieving these objectives compared with conventional monoblock stems. In fact, in Paprosky type II or greater proximal femoral defects, modular stems improve stem stability and facilitate restoration of the center of rotation [23].

Advantages of modular stems

High anatomical adaptability and restoration of biomechanics. The modular design allows independent positioning of the proximal body and distal stem, enabling precise correction of leg length, offset, anteversion, and the center of rotation. The overall survivorship of modular constructs approaches 83 % at 10 years of follow-up. When only revision of the femoral component is considered, published data indicate excellent survivorship (> 95 %) for these implants. Subsidence of more than 5 mm has been reported in fewer than 5 % of patients with modular revision stems [22, 24, 25].

Versatility for different femoral bone defects. Modular systems are suitable for Paprosky type II–IV defects [11, 25, 26]. This facilitates preoperative planning, provides flexibility in managing a wide range of femoral bone defects, and eliminates the need to use multiple implant systems during surgery (Fig. 2).

Reliable distal fixation. In cases of compromised proximal femoral fixation, tapered fluted stems provide reliable distal fixation [25, 27].

Superior long-term clinical outcomes.

Studies have demonstrated high rates of stable stem fixation (up to 90–95%) and excellent long-term survivorship, even in patients with severe proximal femoral bone loss [3, 28].

Disadvantages of modular stems

Risk of mechanical failure at the modular junction. According to one report, the mean incidence is 3.39%, although most failures occurred in implant designs that were subsequently withdrawn from

Table 1

Distribution of patients by age and sex undergoing revision total hip arthroplasty

Stem type	Number of cases		
	mean age (years)	gender	
		male	female
Modular	61.7	28 (40 %)	42 (60 %)
Monoblock	59.1	40 (38 %)	65 (62 %)

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the market [24]. Other studies reported stem fracture rates of only 1.74 % for older modular stems and 0.013 % for newer tapered designs [30]. M. Sukopp et al. [31] described 54 cases of modular revision stem fracture. Overall, this systematic review indicates that such failures are uncommon.

Corrosion and mechanical wear. Despite the use of titanium alloys, micromotion at the modular junction may lead to mechanical wear and corrosion, particularly in the absence of proximal femoral support [24, 32].

Higher risk of intraoperative fractures. Modular stems are associated with a higher incidence of intraoperative fractures. In the study by D. Wang et al. [22], the incidence of intraoperative fractures was 11.6 % and 5.0 % ($p = 0.0004$) for modular and monoblock stems, respectively. Conversely, the incidence of subsidence > 10 mm was significantly higher in the monoblock stem group (4.5 % vs. 1.0 %, $p = 0.003$). Similarly, M. R. Cohn et al. [33] reported a higher rate of intraoperative fractures with modular than with monoblock stems (9.0 % vs. 3.8 %; $p = 0.30$).

No reduction in the incidence of instability. Although modularity allows adjustment of offset and anteversion, studies have not demonstrated a statistically significant reduction in the incidence of postoperative instability [24, 34].

Higher cost. The economic aspect should also be taken into consideration. Modular implants are generally more expensive, and budget constraints remain an important factor [36, 37].

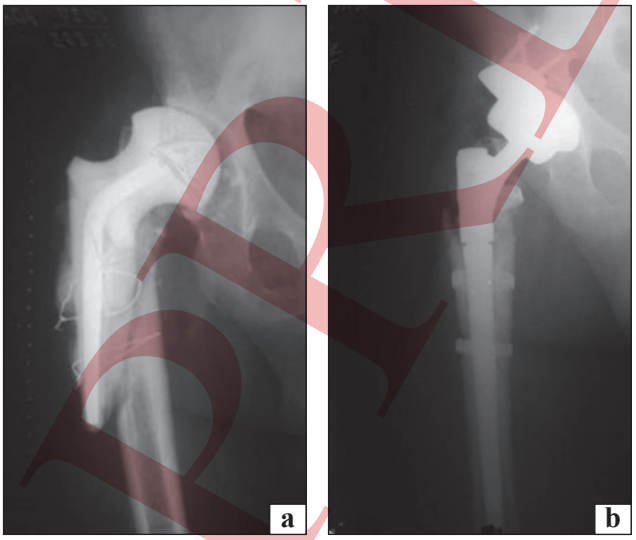


Fig. 2. Patient Ye., 50 years old. Paprosky type IIIB. Preoperative (a) and postoperative (b) radiographic images following revision surgery using a modular revision stem.

The risk of incorrect intraoperative implantation of modular revision stems is primarily related to the complexity of their design and the challenging conditions of revision surgery. Although modularity provides the surgeon with greater flexibility by allowing independent selection of distal fixation, length, and offset, it also transforms a monolithic implant into a multicomponent system, thereby increasing the technical complexity of implantation in the setting of bone loss and the absence of clear anatomical landmarks.

Systematic reviews have demonstrated > 90 % survivorship of modular stems together with consistently favorable Harris Hip Score (HHS) outcomes over 8 years of follow-up [23]. Studies by D. Wang et al., A. Koutalos et al., and B. Zampogna et al. [22, 29, 35] found no significant differences between modular and monoblock stems in terms of postoperative hip function, revision rates, or complications. Marked subsidence occurred more frequently with monoblock stems (Fig. 3), whereas modular stems were associated with a higher risk of intraoperative femoral fracture.

M. Morlock et al. [34] also noted that the choice of stem type is not the predominant reason for revision surgery.

Our clinical observations during follow-up (although complete follow-up was not available for all patients) were largely consistent with the published data. The complication rate was 8.8 % for modular stems and 8.0% for monoblock stems (Table 2). Moreover, after excluding fractures of the obsolete RMD modular stem design, which is no longer used in our practice, the complication rate for modular stems decreased to 4.4 % (Fig. 4). The p-value was 0.834. Thus, the difference in the overall complication rate between modular (8.8%) and monoblock (8.0 %) stems was not statistically significant. The two stem types therefore carry a comparable overall risk of complications.

It is noteworthy that modular stems were more frequently used following removal of cemented stems (25 of 70 cases [35.7 %] vs. 28 of 105 cases [26.7 %] for monoblock stems). In addition, modular stems were more commonly implanted after femoral osteotomy performed to remove the primary femoral stem (15 of 70 cases [23 %] vs. 13 of 105 cases [13 %] for monoblock stems). In most cases, a femoral window osteotomy was performed (9 and 7 cases, respectively) (Fig. 5).

The distribution of femoral bone defects according to the Paprosky classification is presented in Table 3.

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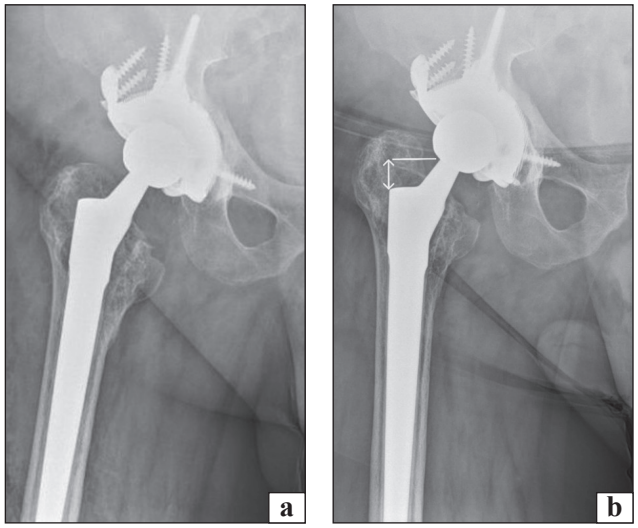


Fig. 3. Patient K., 52 years old. Immediate postoperative radiographic images after implantation of a monoblock revision stem (a) and radiographic images 8 months after surgery demonstrating stem subsidence of 12 mm (b).



Fig. 4. Radiographic image of patient K., 77 years old. Fracture of the RMD implant at the modular junction.

The data presented in Table 3 indicate that, in Paprosky type I–II femoral bone defects, monoblock stems were used more frequently than modular stems (79 % vs. 21 %), whereas for type III–IV defects, modular stems were used predominantly (66.2 % vs. 33.8 %; $p < 0.001$) (Fig. 6).

Clinical outcomes at 1 year after revision total hip arthroplasty were available for 68 patients who received modular stems and 101 who received monoblock stems. Patients who experienced complications were excluded from this analysis (6 and 8 patients, respectively; 14 in total). Functional outcomes in the remaining 155 patients were assessed using the HHS. In the modular stem group, the mean HHS improved from 34.04 ± 2.4 preoperatively to 80.2 ± 3.1 at 1 year. In the monoblock stem group, the mean HHS improved from 38.5 ± 2.8 preoperatively to 83.1 ± 3.3 at 1 year. Analysis of HHS outcomes demonstrated high clinical effectiveness for both stem types ($p < 0.001$ compared with the preoperative level). Comparison of the two groups at 1 year revealed no statistically significant difference ($t = 0.64$; $p > 0.05$), indicating comparable clinical effectiveness of modular and monoblock stems during the study period. These findings indicate no meaningful difference in clinical outcomes and are fully consistent with the published literature [23].

Discussion

The choice of the optimal femoral component for revision total hip arthroplasty remains controversial, particularly in patients with substantial proximal femoral bone loss. Recent evidence indicates that the number of revision procedures continues to increase, underscoring the need for surgeons to adopt a clear strategy for managing different types of femoral bone defects.

Table 2

Complications associated with the use of cementless revision prosthetic stems

Complication	Stem type	
	modular, n = 68	monoblock, n = 101
Periprosthetic fracture	1	1
Infectious complication	1	2
Dislocation	1	1
Aseptic loosening	—	1
Stem fracture	2	—
Distal stem migration > 10 mm	1	3
Total	6 (8.8 %)	8 (8 %)

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In our study, postoperative HHS improved significantly regardless of whether modular or monoblock stems were used, and the difference between the two groups at 1 year was minimal (80.2 vs. 83.1 points). Similar findings were reported by M. Saracco et al. [23], whose analysis of a large body of evidence also demonstrated no significant difference in hip function between these two stem types.

Table 3

Distribution of femoral bone defects according to the Paprosky classification (the groups are not comparable in terms of defect severity)

Stem type	Paprosky defects					Total
	I	II	III A	III B	IV	
Modular	5	16	27	16	6	70
Monoblock	32	48	13	8	4	105
Total	37	64	40	24	10	175

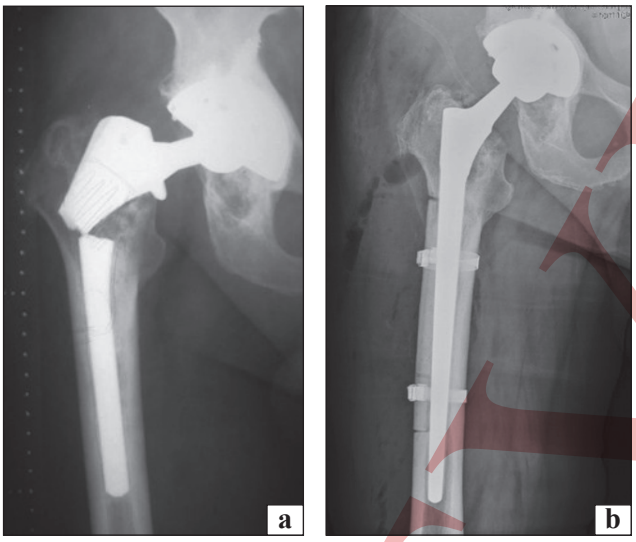


Fig. 5. Patient S., 50 years old. Preoperative radiographic images demonstrating a femoral component fracture (a), and postoperative radiographic images showing the use of a femoral window osteotomy for removal of the fractured femoral component fragment and implantation of a long revision stem (b).

S. Feng et al. [2] reported comparable results, showing that the clinical performance of both modular and monoblock constructs remained similar even 6 years after surgery.

An important finding of our study was the distribution of stem selection according to the Paprosky classification of femoral bone defects. Monoblock stems were used more frequently for type I–II defects (79 % of cases), whereas modular stems were preferred for more severe type III–IV defects (66.2 %). This is fully consistent with current clinical practice: when bone stock is adequately preserved, monoblock stems represent a reliable and cost-effective option, as reported by M. Innocenti et al. [12] and A. Battaglia et al. [7]. Modular stems are particularly indicated when restoration of the center of rotation and implant stability is required in complex anatomical situations.

With regard to complications, the overall incidence was nearly identical in the two groups: 8.8 % for modular stems and 8.0 % for monoblock stems. However, the pattern of complications differed. Significant subsidence (> 10 mm) occurred more frequently in the monoblock group (3 cases vs. 1 case). This is consistent with the findings of D. Wang et al. [22], who reported a significantly higher risk of subsidence with monoblock stems ($p = 0.003$).

Conversely, the increased risk of intraoperative fractures associated with modular stems has

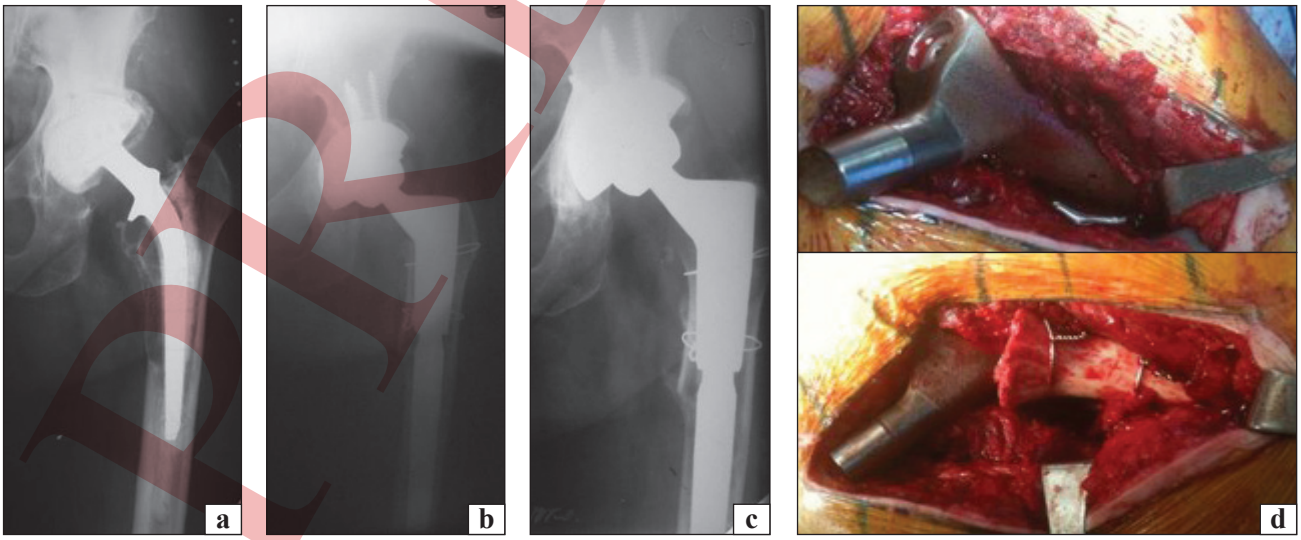


Fig. 6. Clinical case. Patient F., 67 years old: Paprosky type IIIB defect (a), immediate postoperative radiographic images (b), radiographic images at 1.5 years after surgery (c), and intraoperative view of the surgical wound (d).

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been widely discussed in the literature. M. R. Cohn et al. [33] reported a higher incidence of intraoperative fractures during implantation of modular stems than of monoblock stems (9.0 % vs. 3.8 %). In our study, this finding was not confirmed statistically, as the incidence of intraoperative fractures was similarly low in both groups. This may be attributable to the prophylactic use of cerclage wire during implantation of modular stems in our institution.

Particular attention should be paid to fractures of the stem itself. We recorded two cases of modular stem fracture, both involving earlier-generation RMD implants. This is a recognized risk associated with modularity and has been linked to corrosion and wear at the modular junction, as described by D. Lakstein et al. [32] and L. Dreyer et al. [30]. However, more recent evidence reported by B. Zitsch et al. [1] and C. Salib et al. [6] indicates that newer generations of tapered fluted titanium modular stems demonstrate high survivorship and a low risk of mechanical failure, supporting their safe use in clinical practice.

Our study has several limitations, including its retrospective design and the relatively short follow-up period for a proportion of the patients. Nevertheless, the findings confirm that the choice between a modular and a monoblock stem should not be based on the overall superiority of one design over the other but rather on the specific anatomical situation.

Despite these limitations, our results are consistent with current published evidence and support a differentiated approach: the use of monoblock stems for moderate bone defects to reduce costs and the risk of mechanical failure, and the use of modular stems for severe defects (Paprosky type III–IV) to achieve reliable fixation and optimal biomechanical reconstruction.

Conclusions

In conclusion, the outcomes of modular and monoblock revision stems are comparable. However, we believe that modular stems offer advantages in the presence of substantial proximal femoral bone defects (Paprosky type III–IV).

The choice of stem should be based on careful preoperative planning and thorough preparation of all equipment and implants that may be required during the revision procedure.

Conflict of interest. The authors declare no conflict of interest.

Future research. Further studies should focus on the long-term outcomes of modular and monoblock revision stems, particularly implant survivorship, the incidence of mechanical complications, and their effect on bone remodeling. Prospective randomized studies with larger patient cohorts, as well as analyses stratified by Paprosky defect type and associated comorbidities, are warranted.

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Author contributions. Filipenko V. A.— study conception and design, data collection and analysis, manuscript preparation, and scientific supervision; Olinkevych Ye. V. — data analysis and manuscript preparation; Bondarenko S. Ye. — critical revision and editing of the manuscript; Marushchak O. P. — manuscript editing and participation in data analysis; Tankut V. O. — synthesis of the conclusions.

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ADVANTAGES AND DISADVANTAGES OF USING MODULAR STEMS IN REVISION HIP ARTHROPLASTY

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