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Systematisation of the causes that required revision hip replacement, methods of their solution, treatment results in Ukraine

Vitalii Pidhaietskyi[1*] and Mykhailo Pidhaietskyi[2]

Abstract

Background The objective of this study is to organise data on complications following total hip replacement (THA) over a span of 10 years, specifically focussing on cases that necessitated revision endoprosthetic surgeries. The objective is to create a recommendation for an All-Ukrainian registry of initial and repeated hip arthroplasty (HA) and standardise the terminology used to define "revision of total hip replacement surgery".

Methods The retrospective analysis examined 236 instances of revision hip arthroplasty (rTHA) performed at the Institute of Traumatology and Orthopaedics Centre between January 2005 and December 2021. The primary factors for revision were identified through an analysis of the patient's medical records, laboratory results, visual inspection, and the state of the previously implanted prosthesis. Demographic information, primary and revision HA dates, diagnoses, and causes of complications were recorded. The statistical analysis was conducted using the Statistica package (StatSoft), version 12.6 (2015), with a significance level of $p < 0.05$.

Results Out of the 364 patients who were diagnosed with complications, 236 of them (55.17%) needed a procedure called 1rTHA. Among these cases, 152 (41.76%) were specifically diagnosed with aseptic component instability. Significant factors for mechanical loosening were a high body mass index (BMI ≥ 30) and older age, with respective t-values of 2.08 ($p = 0.004$) and 2.59 ($p = 0.045$). Osteoporosis significantly contributed to aseptic loosening and fractures around the implant. The occurrence of infectious complications was frequently linked to chronic infectious diseases ($t = 3.37$, $p = 0.001$). The overall percentage of need for 2rTHA was 27.22% (43 cases), with one case of infectious lesion following the revision.

Conclusions The study emphasises the urgent requirement for standardised terminology and a comprehensive registry for hip arthroplasty procedures. Primary results indicate that cement-free fixation is more effective than cement-based fixation for revision in patients with aseptic instability and that two-stage arthroplasty is effective for treating infectious inflammation. Furthermore, the most effective treatment for femoral fractures with periprosthetic involvement was determined to be open repositioning and osteosynthesis with metal retainers. The aforementioned observations emphasise the need to create a comprehensive registry across Ukraine to support patient care, enable evidence-based practices, and enhance the overall effectiveness of hip arthroplasty operations.

*Correspondence:
Vitalii Pidhaietskyi
vpidhaietskyi@gmail.com

Full list of author information is available at the end of the article

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Clinical trial number Not applicable.

Keywords Total hip replacement, Revision re-replacement, Complications, Aseptic loosening (weakening), Instability

Introduction

Since 1960, total hip arthroplasty (THA) surgeries have increased. These surgeries are now better due to technology and modern materials [1, 2]. Surgical procedures frequently entail the occurrence of complications, which can manifest either immediately or be delayed [3, 4]. When examining global data, surgeons who are actively practising encounter the challenge of uncertainty when categorising delayed causes of complications [5, 6]. Additionally, there is a lack of organisation regarding the timing of these complications, which hinders early prevention efforts [7]. Analysing and organising data on revision hip arthroplasty (HA) factors can help to understand why primary THA fails, prepare for future surgeries, and possibly prevent further surgery.

M.P.Hrytsai et al. [8] described in detail the aetiology, risk factors, localisation, and pathogenesis of periprosthetic infection. T. Karachalios et al. [9] used aggregated statistics from the Australian, Swedish, and UK THA databases from 2013 to 2017 to determine patient-related factors. They assumed that cement-free implants and an ageing population would increase re-prosthetic fracture complications. K. Deere et al. [10] conducted a retrospective observational study using data from the UK National Joint Hospital registry for patients with osteoarthritis as the only indication from 2003 to 2019. They determined the cumulative probability of revision using the Kaplan-Meier method and found that younger patients have a higher risk of recurrent HA. D. Oltean-Dan et al. [11] studied revision procedures, the time between the first and revision surgery (surgical procedures performed to address complications or failures of the initial hip replacement), and the results in the Romanian Regional Centre for Orthopaedics and Traumatology from 2015 to 2020. A retrospective review of 189 revision HA cases found: The main causes under 5 years were infectious complications and instability; osteonecrosis, post-traumatic osteoarthritis, and femoral neck fracture were more common.

R. de Steiger et al. [12] describe the Australian Orthopaedic Association registry creation. Uniform terminology allows multi-level comparison of all primary and revision HA procedures. Iterative procedures of the previous HA that replace one or more prosthetic components are called revisions by the Register. If the component(s) have not been added or removed, the registry does not consider repeated operations revisions. Unifying terms allows researchers to compare findings across countries and analyse revision patterns and causes, which can improve primary and revision HA efficacy. The objective of this study is to organise and analyse data on the factors that contribute to the development of complications following THA within a 10-year timeframe, particularly those that necessitate additional surgical procedures to replace the artificial joint. Furthermore, the objective of the study is to establish the recommendation for a database containing the All-Ukrainian register of primary and repeated HA.

Materials and methods

The study retrospectively reviewed 236 cases of revision hip arthroplasty (rTHA) conducted at the Institute of Traumatology and Orthopaedics Centre from January 2005 to December 2021. The main reason for the repeated procedure was determined based on the clinical history of the patients, the results of laboratory tests, visual examination, and a description of the condition of the removed prosthesis. If there were multiple reasons, classification was conducted according to priority from more to less threatening. Demographic data of each patient (age, gender, and body mass index (BMI)), dates of primary and revision HA, diagnosis, and causes of complications were documented. The patients were dominated by men (57%), with a mean age of 67.7±2 years and mean BMI of 27.2 for men and 26.4 for women. A study was approved by the Ethics Commission of the Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine, No. 56,921. The authors informed the participants about the anonymous and voluntary participation, and the participants provided their consent. Figure 1 shows a diagram of the research algorithm for the first and subsequent HA revisions for a certain diagnosis.

The study employed clinical, radiological, and statistical methodologies. A significant correlation ($\chi 2$) was found through statistical analysis between the cause of hip recurrence and patient-related prerequisites, surgical errors, or endoprosthesis. The statistical analysis was conducted using the Statistica package (StatSoft), version 12.6 (2015), with a predetermined level of statistical significance set at $p<0.05$.

For diagnosing different causes of revision, the following classifications and methods were used:

1. Aseptic Component Instability: Diagnosed using radiological examinations and classified according to the International Statistical Classification of Diseases and Related Health Problems (ICD-10) codes T84.03 to T84.039.

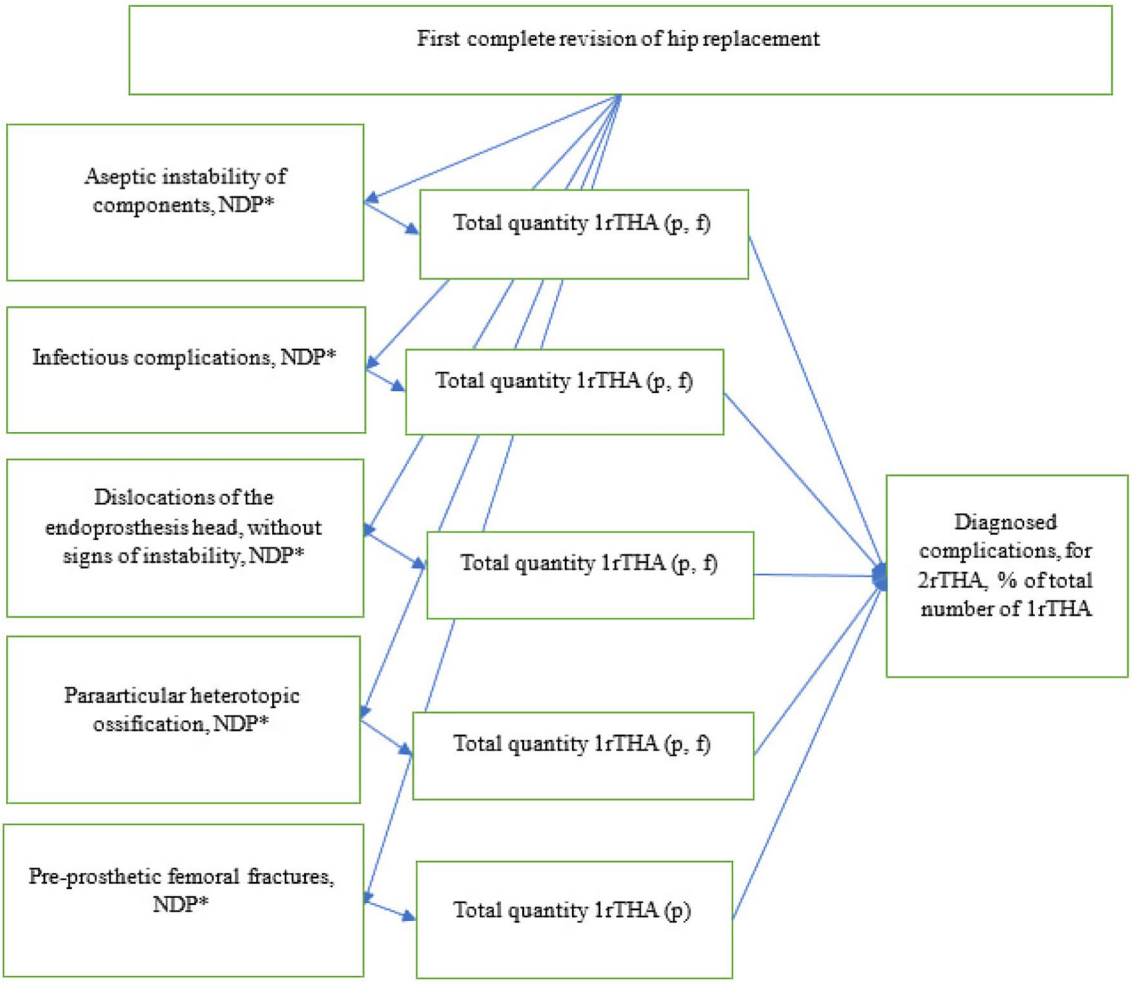

Fig. 1 Research algorithm for the first and subsequent hip revisions based on a specific diagnosis. *Note* * – number of diagnosed patients. *Source* compiled by the author

2. Infectious Complications: Identified through microbiological analysis of samples, with the primary cause being Staphylococcus aureus in 40% of cases. Diagnoses were classified according to ICD-10 codes T84.5 to T84.59 and T84.7.
3. Osteoporosis and Osteolysis: Diagnosed using the Barnett-Nordin and Spector-Romagnoli indices, with ICD-10 codes T84.050 to T84.059 and M89.5.
4. Prosthetic Component Failures: Identified through visual examination of the removed prosthesis and classified under ICD-10 codes T84.06 to T84.069 and T84.09.
5. Dislocations of the Endoprosthesis Head: Diagnosed through radiological examinations and classified according to ICD-10 codes T84.02 to T84.029, M24.3, M24.4, and S73.0.
6. Paraarticular Heterotopic Ossification (PHO): Diagnosed through radiological examinations and classified based on the presence of osteophytes, duration of surgery, and blood loss.

The Barnett-Nordin index measures the cortical bone thickness at the middle of the second metacarpal bone radiographically [4–6]. Ratio of combined cortical thickness (CCT) to bone outer diameter (OD). The dimensionless ratio represents cortical bone thickness relative to bone width. The exact threshold values used to distinguish osteoporotic and non-osteoporotic bone depend on research and demographic criteria. A lower value indicates thinner cortices and osteoporosis risk. Numerous studies have used a threshold range of 0.42 to 0.45 to define osteoporosis, but these values vary by demographic.

The analysis for each subsequent revision was evaluated based on the algorithm employed for the primary total hip arthroplasty (THA), determining the necessity for revision based on the diagnoses established. The proposed sequential digital terminology, such as 1rTHA and 2rTHA, was utilised to easily track the chronological order of revision procedures and trace the path from the primary procedure. The initial revision's outcome

was determined by calculating the total percentage of the requirement for a subsequent revision.

Results

The main objective of the study was to determine the prerequisites for the occurrence of complications after the first THA, especially those that require revision endoprosthetic operations. The relationship between initial and revision (repeated) operations provides some insight into the extent to which revision HA burdens health resources by region or country in general. The number of HA audits is influenced by many factors, such as: the sufficiency of the funds for operations in the budget, the financial viability of the patient, the availability of qualified orthopaedic surgeons, and the availability of equipment and endoprosthesis.

There is no nationwide reporting on THA and rTHA. Creating a registry with a unified report submission form is an urgent issue, given the growing number of THA operations. Registers provide an opportunity to systematise and analyse the reasons that lead to revision operations, and understand the trend in increasing/decreasing cases for a specific reason. The lack of information about the number of primary and revision HA, the causes and consequences of this surgical intervention, leaves the professional Ukrainian community without the opportunity to evaluate the effectiveness of their work, compare their results with the results of other specialists, exchange the experience gained, and acquire additional theoretical knowledge. For this purpose, the Scandinavian unified common database was created to compare demographic indicators and HA revision results in countries such as Denmark, Sweden, and Norway back in 2007 [13]. Later, other countries joined this initiative and the Nordic Arthroplasty Register Association – NARA was established, which currently has a research collaboration with about ten other endoprosthetic associations in the world through the International Society of Arthroplasty Registers – ISA [14].

As the authors of the Swedish arthroplasty registry note in their 2022 report, by filling out the registry, they have the opportunity to conduct in-depth analysis, and cooperate with the international professional community: "The line between what is considered a clinical study and operational analysis or improvement work is blurred. The analysis of registries is aimed at obtaining results for providing feedback to improve medical practice and is based on scientific methods" [15]. From the total number – 364 patients who were diagnosed with complications, 236 (55.17%) patients required 1rTHA, of which 152 were diagnosed with aseptic component instability, accounting for 41.76%. According to the international statistical classifier, classification of diseases and health problems, ICD-10 (International Statistical Classification of Diseases and Related Health Problems) this diagnosis has codes from T84.03 to T84.039, referred to as "antiseptic loosening" or "loosening" and includes the following gradations: mechanical loosening of the internal prosthetic joint, right hip joint (HJ), left HJ, other internal prosthetic joints, unspecified internal prosthetic joint, respectively. Comparing the results of this study, according to the ICD-10 classifier, 1rTHA for this category of complications remains the main reason for repeated surgery in Australia and Sweden and ranks 2nd in the distribution in the United States [16, 17].

Reliable prerequisites for the development of mechanical loosening of the prosthetic joint were: high BMI (BMI≥30, WHO classification, obesity) ($t=2.08$, $p=0.004$). The physical condition classification of the patients was not applied to patients in the study (ASA – American Society of Anesthesiologists), which is used in other international studies that have been linked to comorbidities, but the impact of chronic diseases on the cause of THA revision was considered. According to the observations of colleagues from Sweden, a high grade of ASA affects the need for revision more than BMI or age [16]. The next reliable factor for performing 1rTHA was older age ($t=2.59$, $p=0.045$). Investigating the prerequisites revising a complex, considering the first (BMI) and second (age) factors, the main conclusion is that, for older patients with a high BMI and the presence of concomitant chronic diseases, the probability of such complications as the mechanical loosening of the endoprosthesis substantially increases.

Osteoporosis is a morphological disease of the skeleton, characterised by a decrease in bone mass and a violation of the microarchitectonics of bone tissue, leading to increased bone fragility and a subsequent increase in the risk of fractures. At the beginning of the study, calculations were used to determine the contribution of osteoporosis-related complications to determine the component of the diagnosis using the Barnett-Nordin ($t=10.04$, $p=0.001$) and Spector-Romagnoli indices ($t=4.7$, $p=0.003$), which led to aseptic attenuation, and the Barnett-Nordin index ($t=2.0$, $p=0.001$), which were the cause of periprosthetic fractures. This diagnosis has codes from T84.050 to T84.059 and M89.5 according to ICD-10, where the gradation has the same logical sequence from, category name "periprosthetic osteolysis of the internal prosthetic joint", right, left, for example – T84.051 periprosthetic osteolysis of the internal prosthetic joint of the right hip joint. Osteoporosis, as a disease in a large number of cases, is the cause of primary THA, but in the future, it is its modification – osteolysis (M.V. Polulakh [18] characterises osteolysis as resorption of the area of bone in contact with the endoprosthesis component, without subsequent replacement with another tissue) is the reason for HA revision. The study

did not analyse cases of osteolysis (without loosening) as a reason for 1rTHA, although osteolysis has a separate code in the diagnosis classifier for THA and CD-10 revision. – M89.5. On osteolysis, in national registries, the following data are provided: The Australian Register – 364 (2.65%), at the initial diagnosis of osteoarthritis; Swedish 727 – (5%), and American – 6855 (2.3%) operations, out of the total number of THA performed, Chinese researchers provide the following result for 1rTHA performed in one centre – 48 (6%) [7; 12; 17].

The following factors for conducting 1rTHA were related directly to the prosthesis: outdated prosthetic designs (t=7.8, p=0.001), tear and wear of the polyethene insert (t=9.4, p=0.0024) and those that can be attributed to surgical errors – cementation breaks (t=3.9, p=0.0037), incorrect arrangement of components (t=2.26, p=0.004), and cyst-like hip rearrangement (t=5.5, p=0.003). This category of causes for 1rTHA in the reports of endoprosthesis associations refers to the code of non-specific diagnostics and is classified as "other". Table 1 partially presents the classification of diagnoses for which revisions of hip endoprosthesis are performed.

In many studies, patients are identified not only by the codes of diagnoses for revision, but also by the codes of the revision procedure, which are assigned designations distributed according to the location (femur, femur, acetabular cavity) and the type of surgical intervention (revision, removal, or replacement). The first relevant diagnostic code in the list is used as the main indication for rTHA, this allows generalising the number of patients with related diagnoses [9].

Infectious complications were most often associated with chronic infectious diseases of internal organs (t=3.37, p=0.001) and in most cases had an endogenous way of infection, that is, due to the weakening of the protective properties of the patient's healthy microflora. Microbiological analysis of most samples was performed, the cause of infection was most often *Staphylococcus aureus*, in 40% of cases. The underlying causes of infections in the reports referred to in this paper were not investigated, except for the specialised work of American colleagues, when only episodes with concomitant organ transplantation were included in the cohort of subjects, and the purpose of the study was to determine which of the diagnoses of aseptic weakening or infection is the main cause for the revision procedure [19]. For example,

Table 1 Reasons for revision of endoprosthetics and corresponding diagnoses according to the ICD-10 classification are

Name used	Suggested name	ICD-10 code	Description
Aseptic instability of components	Aseptic loosening	T84.03	Mechanical loosening of the internal prosthetic joint
		T84.030, 031, 038, and 039	Loosening of the right, left, and inner parts of the prosthesis, unspecified
Absent	Aseptic weakening or loosening caused by osteolysis	T84.05	Periprosthetic osteolysis of the internal protengo joint
		T84.050, 051, 058, and 059	Periprosthetic osteolysis of the right, left, and inner parts of the prosthesis, unspecified
Absent	Osteolysis	M89.5	Osteolysis
		M89.55	Hip osteolysis
Absent		T84.06	Wear of the support surface of the inner prosthetic joint
		T84.060, 061, 068, and 069	Wear of the right, left, inner part of the joint support surface, unspecified
Absent	Other	T 84.09	Other mechanical damage to the internal prosthetic joint
		T 84.4; T84.4; T84.8, and T84.9	Misalignments, breakdowns.
Dislocations of the endoprosthesis head	Instability	T84.02	Dislocation of the inner joint prosthesis
		T84.020, 021, 028, and 029	Dislocation of the right, left, inner part of the prosthesis of the inner joint, unspecified
		M24.3 and M24.35, M24.4, and M24.45	
		S73.0 (S73.00, S73.01, S73.02, S73.03, and S73.04)	Subluxation and dislocation of the hip
		T84.01	Internal joint prosthesis failure
		T84.010, T84.011, T84.018, and T84. 09	Failure of the right, left, inner part of the prosthesis of the inner joint, unspecified
Periprosthetic femoral fractures	Periprosthetic fracture around the internal prosthetic joint	M97	Periprosthetic fracture around the internal prosthetic joint
		M97.0	Periprosthetic fracture around the inner prosthetic hip joint
		M97.01, 97.02, 97.8, and 97.9	Fracture of the right, left, and inner parts of the prosthesis, unspecified

Source compiled by the author based on P.H. Gundtoft [26] and L.S.M Gomes [32]

the Australian revision study, when diagnosed for THA osteoarthritis, notes that all cases of 1rTHA diagnosed with an infectious complication were excluded "due to the difficulties associated with the analysis of sepsis-related revisions", but they were included in subsequent revision cases [12]. Fluctuations in the proportion of cases for the diagnosis of "infection" in studies may depend on which diagnosis, in the opinion of the researcher, is considered the main one. However, this category (infectious complications) still has a high percentage of surgical revisions, ranked 2nd in the United States and 4th in Sweden [16, 17]. Figure 2 shows updated data unified with the international system for determining the diagnosis of ICD-10.

Diagnoses according to the ICD-10 classification for infectious complications are divided according to the localisation of infection: T84.5 – infection and inflammatory response of the internal prosthetic joint, T84.50 – non-specific infection and inflammatory response of the internal prosthetic joint, T84.51 and T84.52 – right and left parts, respectively, T84.59 – unspecified. Separately identified T84.7 diagnosis – infection and inflammatory response due to other internal diseases. The second most important cause of infectious complications at the beginning of the study was determined to be the instability of prosthetic components (t=3.14, p=0.002), the question arose – to which category the cause of this complication should be attributed [17].

Complications such as injuries to the endoprosthesis head, according to the ICD-10 classifier, are grouped into categories under the general name – "Instability", including gradation by location, the category of complexity "subluxation", "dislocation", "breakdown" have coded marks T84.02, M24.3, and S73.0 inclusive with subcategories from S73.001 to S73.046, but despite the variety of diagnoses in this category, the main causes of dislocations that the following were established in this study: those related to the patient – high BMI (t=4.4, p=0.004); those that can be attributed to surgical errors – vertical position of the artificial acetabular cavity "which creates a higher level of stress-strain state in the acetabular component" (t=2.28, p=0.009); directly related to the prosthesis – the head diameter is 28 mm (t=22.1, p=0.005) [20]. According to other studies, 4 to 20% of repeated revisions are performed in this category of complications

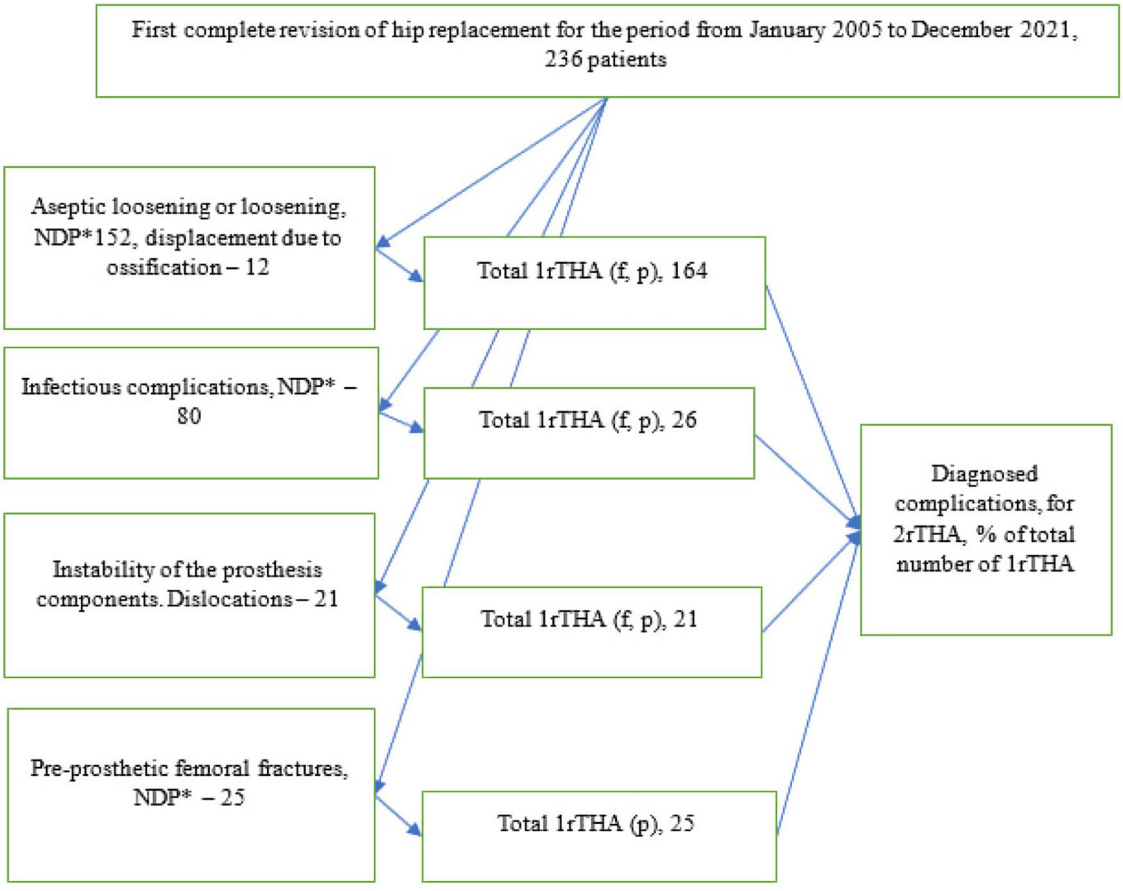

Fig. 2 Research algorithm for the first and subsequent hip revisions based on the updated diagnosis. *Note* * – number of diagnosed patients. *Source* compiled by the author

(20.4% in the United States) [19]. Surgical treatment of dislocations was more effective than closed elimination ($\chi 2=15$; $p=0.005$; $n=2$), in 21 cases 1rTHA(p) was performed with component replacement.

Periarticular heterotopic ossification (PHO): the causes of heterotopic ossification were: the presence of osteophytes ($t=2.39$, $p=0.006$), the duration of surgery of more than 2 h ($t=3.7$, $p=0.005$), blood loss of more than 500 ml ($t=3.4$, $p=0.006$). In the treatment of periarticular heterotopic ossification, surgical removal of ossification was the most effective method of treating and restoring joint functions, although ossification relapses occurred in 70% of cases. In 12 cases of PHO, during the ossification removal process, it was necessary to replace the components of the prosthesis, due to their loosening, the cases were reclassified in the category of "aseptic loosening".

To enhance the quality of care and results for patients undergoing hip replacement surgeries, it is imperative to establish an All-Ukrainian registry for initial and repeated HA. The purpose of this registry is to function as a centralised database for the collection, analysis, and reporting of data on all HA procedures conducted nationwide. To establish uniformity in reporting and enable meaningful comparisons with international registries, the registry will standardise the terminology employed to describe complications and revisions. Implementing this approach will not only facilitate the identification of patterns and risk factors but also enable the development of evidence-based recommendations for optimal practices.

Comprehensive data on each HA procedure, encompassing patient characteristics, surgical methodologies, implant categories, and post-operative results, will be included in the registry. Analysis of this data will be conducted to detect recurring patterns of problems, including aseptic loosening, infectious complications, and periprosthetic fractures, which are frequently cited as reasons for revision surgeries. The findings obtained from this analysis can be utilised to enhance surgical procedures, choose suitable implants, and optimise patient care. Furthermore, the registry will serve as a forum for researchers to carry out investigations on the extended-term results of HA procedures, so enhancing the worldwide scientific knowledge on hip arthroplasty.

An essential advantage of the registry is its capacity to deliver periodic reports and reviews to healthcare practitioners, researchers, and policymakers. The implementation of this feedback loop will facilitate the ongoing enhancement of care quality and the adherence to optimal practices. For example, if a specific implant type or surgical technique is discovered to have elevated rates of complications, this knowledge can be promptly shared with surgeons to adapt their work practices accordingly. Furthermore, the registry will function as a significant asset for enlightening patients and their families about the potential hazards and advantages of HA procedures, thus fostering well-informed decision-making.

Ultimately, the creation of a comprehensive registry for hip replacement procedures (HA) across Ukraine is a crucial measure aimed at improving the standard of treatment and results for patients. By standardising terminology, gathering extensive data, and offering consistent feedback, the registry will enhance the advancement of evidence-based practices and enhance the whole healthcare system. This program will not only profit patients in Ukraine but also make a valuable contribution to the worldwide endeavour to progress the field of hip arthroplasty.

Discussion

The percentage of revision HA is growing, but currently, very limited data is available for analysis, regarding the frequency of primary procedure reviews on a national scale, diagnoses in connection with which primary and revision procedures were conducted, and demographic data. In addition, there is no data on whether the cause of the initial diagnosis affects the diagnosis for the review procedure and the duration of a positive review result. Therefore, it is important to initiate procedures for the collection and processing of THA-related data, the heads of the Ministry of Health must plan budget expenditures; surgeons to understand trends and thereby improve the methods of performing operations; medical professionals must provide patient advisory services.

Having systematised the information on the prerequisites for the occurrence of complications after total hip replacement over a 10 year period, especially those that require revision endoprosthetic operations, it was concluded that: aseptic loosening, which required 100% of revision reviews was quantitatively and qualitatively the most expensive procedure on the part of finances and time. The majority of 64 cases (40.5%) after primary THA showed signs of aseptic loosening (weakening) after 5 years. Of the 158 cases, total instability of the endoprosthesis components (without signs of heterotopic ossification) was established in 43 (27.2%) cases, during 1rTHA (f), the difference in the results of the revision procedure using only 17 new components (39.5%), or a combination of 20 new and restored (reconstructed) elements (46.5%) was not detected. "The use of components with a cement fixation type for revision had substantially worse results compared to cement-free ones and a substantially shorter service life" [3]. Repeated diagnosis of aseptic loosening of one of the components was recorded in 8 (18.6%) cases.

Loosening of the acetabular component (AC) was reported in 65 (41.1%) cases, 1rTHA (p-AC) results were evaluated by the frequency of diagnosis for 2rTHA, out of a total of 28 cases of diagnosis – loosening only 2 cases

concerned modified components, and 23 cases of loosening primary AC (Table 2).

Therefore, in patients diagnosed with loosening of AC, the results of 1rTHA (p-AC) are better when using new elements with a cement-free type of fixation, since most of them do not need to be revised for 10 years. Loosening of the femoral component (FC) in 50 (31.6%) cases required its replacement, the results of 1rTHA (H-FC) were also evaluated by the frequency of cases of the need for 2rTHA. The total number of diagnoses for 2rTHA was relatively small – 7, of which only 1 diagnosis concerned the replaced element, 6 concerned the primary components of the prosthesis (less than 1 year – 1 case, 1–5 years – 5, and 5–10–1 case). In patients diagnosed with loosening of FC, the results of 1rTHA (p-FC) replacement of components with cement and cement-free fixation types did not substantially differ. The cumulative percentage of need for 2rTHA was 27.22% (43 cases), and only one case after the revision procedure recorded an infectious lesion (1rTHA(p-AC)). With a significance level of $p<0.05$, the statistical analysis was performed using the Statistica package (StatSoft), version 12.6 (2015). Significant variables associated with mechanical loosening were a high body mass index (BMI≥30) and advanced age, with corresponding t-values of 2.08 ($p=0.004$) and 2.59 ($p=0.045$). Osteoporosis played a critical role in causing aseptic loosening and fractures around the implant. Chronic infectious diseases were strongly associated with the increased incidence of infectious complications (t=3.37, $p=0.001$).

As previously noted, 12 episodes with the initial diagnosis of PHO, due to the need to replace the components of the prosthesis, were reclassified to the category of "aseptic loosening", the concomitant diagnosis was defined as heterotopic ossification. Comparing the results of their limited study (72 patients), A.K.Calek et al. [21], after conducting a study on the revision of THA as a result of aseptic loosening with a single modular femur and modified extended trochanter osteotomy, concluded that aseptic loosening is still one of the most common causes of revision complete hip replacement. Concomitant radioscopic pathology of PHO in their study accounted for 31 (46.27%) cases. According to various sources, the percentage of this complication after the conducted THA can even reach 90%, in a study by American researchers conducted from September 2010 to October 2019 at the University of California, the share of PHO was recorded in 80 (3%) cases of the total number of 2,541 patients included in the study. Meta-analyses, retrospective reviews, and controlled randomised trials demonstrate a high degree of variability in the frequency of PHO, and it has been reported, in particular, that after hip replacement, it can range from 2 to 40% [22; 23].

The results of this study confirm a higher percentage of the need for re-prosthetics as a result of aseptic loosening, indicated in the papers of X. Feng et al. [7], H. Mathur et al. [24]. Aseptic weakening is the primary reason for revision, and in the later stages after surgery, infection, instability, and periprosthetic fractures were more prevalent in the early failure group. Infectious complications after THA are not only highly detrimental to the patient's quality of life but also impose a significant burden on the institution and the entire healthcare system [7]. These complications are linked to the need for multiple surgeries, an elevated risk of death, and poorer outcomes following audits. Following a thorough examination of the cases requiring 1rTHA and the presentation of statistics on the occurrence of complications in the global HA experience, the focus of the discussion shifted to the categorisation of these infections. This categorisation enables orthopaedic surgeons to assess the severity or chronicity of the infection, predict the intricacy of the treatment strategy in advance, and guarantee the availability of all required funds for the revision operation. The temporal duration of the infection is a crucial determinant in the classification of hip infections [24]. Historical classification of infections has been based on acute and chronic categories. However, it has become evident over time that additional distinction is necessary. The classification of hip infections into early, delayed, and late stages is still a subject of debate, with no consensus on the precise delineation of these time intervals. The classification of infections is based on the site, namely surface and deep, and the etiological agent, namely bacterial and fungal.

The system of classification and time distribution proposed by Japanese researchers D. Tsukayama et al. [25]. P.H. Gundtoft et al. [26] is often used. R.J. Liukkonen et al. [27] analyse the incidence of infections during the first year after THA, after conducting a study on the causes of re-prosthetics from 2008 to 2021, based on the Finnish Centre for Orthopaedics, they conclude that the lack

Table 2 Evaluation of rTHA results

Component	Total cases	1rTHA (*p*-AC)	2rTHA diagnosis	Modified components	Primary components	Time period	Statistical analysis
Acetabular Component (AC)	65 (41.1%)	28	Loosening	2	23	Less than 1 year: 5 < br > 1–5 years: 9 < br > 5–10 years: 9	t-values: 2.08 ($p=0.004$) for BMI, 2.59 ($p=0.045$) for age
Femoral Component (FC)	50 (31.6%)	7	Loosening	1	6	Less than 1 year: 1 < br > 1–5 years: 5 < br > 5–10 years: 1	t-values: 2.08 ($p=0.004$) for BMI, 2.59 ($p=0.045$) for age

of a gold standard for classifying infectious complications still creates numerous problems for early recognition of this serious complication, which can lead to treatment failures, which is consistent with the findings of the current study [28–32]. According to the American Academy of Orthopaedic Surgeons, the most common diagnosis in recent years, especially for patients under 55 years of age, is an infectious complication, for a sample of 5,153 patients from 18 to 65 years of age included in the study from 2012 to 2020, it was (20.8%), while instability, periprosthetic fractures, aseptic loosening was 15.1%, 13.2%, 9.4% of cases [33].

Instability of the prosthesis, dislocations of the head of the endoprosthesis, according to the conclusions made according to many studies comparing the results of the diagnosis for the first revision, "instability of the prosthesis in the form of subluxation, dislocation, breakage" had the highest frequency for the appointment of a second revision, compared with other diagnoses. There were no differences in the frequency of the second revision in the diagnoses for the first revision for the diagnosis of loosening, periprosthetic fracture, and/or osteolysis. Previously, dislocations were a very common indication for rTHA, followed by aseptic loosening and/or periprosthesis infection, but numerous advances over the past few decades have specifically reduced the number of cases of prescribing a revision procedure for this diagnosis.

Periprosthetic fractures are more common in the early stages after primary THA, they are associated with undetected microcracks during surgery and can also be associated with concomitant diseases. Australian researchers noted that the diagnosis of periprosthetic fracture during 10 years of follow-up recorded the highest mortality rate, compared to other reasons for revision and specified that patients were mostly older and had concomitant chronic diseases, but due to the use of the latest materials and technologies, the risk factor of both the fracture itself and the consequences of the operation performed in connection with it can be substantially reduced [12]. In periprosthetic fractures and the primary diagnosis of osteoporosis, the use of metal-cement osteosynthesis allows for achieving stable fixation of bone fragments, and prevents the development of complications in the form of migration of implants and secondary displacement of fragments.

Conclusions

These findings highlight the urgent need for a comprehensive and consolidated Ukrainian registry for total and revision hip arthroplasty. A 16-year study of 236 revision cases reveals complex complications and risk factors that require careful monitoring and analysis. The results show that total hip arthroplasty problems are complex and diverse, with aseptic component failure being the main cause of revisions. High body mass index, advanced age, and osteoporosis are also risk factors that affect revision rates, according to the study. To improve total hip arthroplasty outcomes, patient care and risk assessment must be personalised. The Ukrainian orthopaedic community would benefit from the proposed registry of primary and recurrent hip arthroplasties. A registry like this would help surgeons evaluate their work, compare outcomes nationally and internationally, and contribute to arthroplasty knowledge worldwide. This would also help identify complications, improving surgical procedures and prevention. Finally, this study provides valuable insights into hip arthroplasty revisions in Ukraine and lays the groundwork for a national arthroplasty registry to improve orthopaedic practice in the country. This project aims to close data gaps and improve hip arthroplasty in Ukraine to global standards.

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Author contributions
V.P., and M.P.: conceptualization, methodology, data curation, writing-original draft preparation. V.P.: visualization, investigation, validation, and supervision. M.P.: software, writing-reviewing, and editing. All authors read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
A study was approved by the Ethics Commission of the Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine, No. 56921. The authors informed the participants about the anonymous and voluntary participation, and the participants provided their consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1] Department of Traumatology and Orthopedics of Adults, Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine, Kyiv 01601, Ukraine
[2]Department of Traumatology and Orthopedics, Bogomolets National Medical University, Kyiv 01601, Ukraine

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