GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 1 (370) Январь 2026

ТБИЛИСИ - NEW YORK

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press. Published since 1994. Distributed in NIS, EU and USA.

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

GEORGIAN MEDICAL NEWS
NO 1 (370) 2026

Содержание:

GEORGIAN MEDICAL NEWS
No 1 (370) 2026

ADVANTAGES OF COMPUTER-NAVIGATED KNEE REPLACEMENT: IMPLICATIONS FOR BIOMECHANICS, PAIN MANAGEMENT, AND RECOVERY

George Tchumburidze*, Lukhum Tchanturia, Irakli Gogokhia.

DNewhospitals Tbilisi, Georgia.
Ivane Bokeria University Hospital Tbilisi, Georgia.
New Vision University Tbilisi, Georgia.

Abstract.

Background: The knee joint, through its anatomy, biomechanics, and function, represents a highly complex mechanism. In recent years, the implantation of knee prostheses has markedly increased worldwide, driven by the need to reduce pain and improve mobility. Although total knee arthroplasty currently remains the most common treatment for advanced-stage gonarthrosis, achieving optimal surgical outcomes, restoring full functional mobility, and accurately predicting postoperative results continue to pose significant challenges.

Objectives: The aim of our study was to determine the advantages of surgical treatment of gonarthrosis using a computer-assisted navigation system and to assess how these advantages influence the biomechanical characteristics of the knee joint and postoperative pain.

Methods: A total of 100 patients who underwent primary total knee replacement between 2020 and 2024 (using only a sliding implant with patellar resurfacing) were evaluated on Randomized bases. Patients were allocated to the two study groups using a stratified randomization approach with a 1:1 allocation ratio. Stratification was performed by sex to ensure an equal distribution of male and female patients between the navigation-assisted total knee arthroplasty group and the standard surgery group. This approach was chosen to minimize potential confounding related to sex-specific differences in postoperative pain perception and functional recovery. All eligible patients meeting the inclusion criteria were assigned to one of the two groups according to the predefined randomization scheme prior to surgery.

All patients received a prosthesis with a tibially fixed polyethylene insert and preservation of the posterior cruciate ligament (Fa. Aesculap). The patients were divided into two main groups: the N-group, who underwent computer-assisted navigation–guided total knee arthroplasty with patellar resurfacing (OrthoPilot®, Fa. B. Braun, Aesculap), and the S-group, who underwent standard total knee arthroplasty with patellar resurfacing. Pre- and postoperative pain assessment was performed using the 0–10 Numerical Rating Scale (NRS), while the knee joint range of motion was evaluated using the neutral-zero method. The postoperative follow-up period was 6 months.

Results: No significant differences were observed between the groups with respect to age or sex. In the preoperative period, 22.0% of patients in the navigation-assisted group reported moderate pain, whereas 78.0% reported severe pain. In the standard surgery group, moderate pain was observed in 26.0% of patients, and severe pain in 74.0%. According to postoperative day 4–5 data, 38% of patients in the N group and 26% in the S group reported mild pain. Moderate pain was present in 48% of the N group and 52% of the S group. Severe pain was noted in 14% of the N group and 22% of the S group. Importantly, pain distribution between the N and S groups during postoperative days 4–5 did not differ significantly ($P > .05$).

At the 6-week postoperative evaluation, 46.0% of patients in the navigation group (N) reported no pain, 40.0% reported mild pain, 12.0% reported moderate pain, and only 2.0% reported severe pain. In the standard group (S), 30.0% were pain-free, 40.0% reported mild pain, 28.0% moderate pain, and 2.0% severe pain. At the 6-month postoperative follow-up, 68% of patients in the N group were pain-free, 28% had mild pain, and 4% had moderate pain. In the S group, 60% were pain-free, 34% reported mild pain, and 6% reported moderate pain. Based on proportional distribution between groups, no statistically significant differences were identified ($P > .05$).

Frequency analysis showed that the mean preoperative knee flexion amplitude in the navigation-assisted group (N) was $M = 109.70°$, $SD = 10.32$, while in the standard group (S) it was $M = 104.40°$, $SD = 10.48$. By postoperative day 5, a marked reduction in flexion amplitude was observed in both groups (N: $M = 58.70°$, $SD = 15.28$; S: $M = 46.00°$, $SD = 11.07$). During subsequent rehabilitation, a clear recovery trend was noted. At 6 weeks postoperatively, the mean flexion amplitude increased to $M = 119.40°$, $SD = 6.97$ in the N group and $M = 110.00°$, $SD = 9.04$ in the S group. At the 6-month follow-up, both groups reached their maximal recovery levels; however, the navigation-assisted group continued to demonstrate superior knee flexion amplitude (N: $M = 121.00°$, $SD = 7.00$; S: $M = 113.40°$, $SD = 8.48$).

Conclusions: Comparative analysis between the groups demonstrated that, overall, patients who underwent navigation-assisted surgery exhibited significantly greater knee flexion amplitudes across the four time points assessed ($F = 31.343$, $p < .001$). Notably, the between-group differences did not emerge immediately but became pronounced at later stages—specifically from the 6-week to the 6-month postoperative period. A statistically significant interaction between time and group was identified (Amplitudes × Group: $F(3,96) = 3.458$, $p = .019$), indicating that the rate of improvement in knee flexion amplitude differed between groups. Patients treated with computer-assisted navigation recovered motion amplitude more rapidly and more completely than those who underwent the standard procedure.

The results further show that by postoperative week 6, 16% more patients in the navigation-assisted group had achieved a pain-free status compared with the standard surgery group.

Conversely, moderate pain was observed 16% more frequently in the standard technique group than in the navigation group at the same postoperative interval.

Key words. Gonarthrosis, navigation in knee endoprosthesis implantation, orthopilot, total knee arthroplasty.

Introduction.

It should be taken into account that in patients over 60 years of age, approximately 90% of gonarthrosis cases ultimately require endoprosthetic replacement. Consequently, this condition carries both medical and social significance. Although total knee arthroplasty (TKA) is currently the most common method for treating advanced-stage gonarthrosis, achieving optimal functional recovery of mobility and accurately predicting postoperative outcomes remains a major clinical challenge [1-4].

The idea of developing a computer-assisted navigation system emerged from the need to address the problems described in the global medical literature regarding knee joint arthroplasty. The concept was based on establishing a precise relationship between anatomically accurate implant positioning, restoration of the joint's postoperative biomechanical function, and, ultimately, the longevity of the prosthesis. Navigation systems such as OrthoPilot not only determine patient-specific bone resection planes but also assess the degree of ligament tension and suggest the most appropriate implant size for the individual patient [5,6].

Why is it so crucial for a knee endoprosthesis to match the patient's anatomy as closely as possible?

The knee is a complex joint with individualized biomechanics. Approaching every patient with a standardized anatomical model disregards their unique structural characteristics. This, in turn, alters the natural range of motion and affects all surrounding structures, including patellar tracking, ligament tension, and overall joint stability. This also explains why up to 20% of patients remain dissatisfied after conventional, non-navigated knee arthroplasty [2,3]. We suspect that such dissatisfaction is largely attributable to disruption of the patient's individual knee anatomy, including alterations in anatomical and mechanical axes.

Using a computer-assisted system, it becomes possible to simulate patient-specific joint kinematics and determine the optimal implant position. This approach offers multiple advantages: preservation of the knee's original biomechanics and mobility, reduced postoperative pain, faster rehabilitation, and significantly lower complication rates.

Since navigation-assisted arthroplasty such as OrthoPilot is relatively new and requires additional specialized training, its widespread adoption globally remains limited [4]. Consequently, scientific publications addressing the outcomes of computer-assisted knee arthroplasty are scarce. Existing studies in the international literature predominantly focus on postoperative radiographic outcomes of navigated TKA [7]. However, clinical outcomes— postoperative biomechanical characteristics of the knee, and pain intensity—are equally important and require thorough evaluation [8-15].

The aim of our study is to identify the advantages achieved through minimizing deviations in the mechanical axis of the lower limb. Achieving absolute anatomical accuracy is practically impossible without computer assistance. The study investigates correlations between pain intensity and anthropometric parameters. We compare navigation-assisted procedures with the standard technique and evaluate how these advantages influence postoperative pain [16-29].

Materials and Methods.

The Randomized study included patients who underwent primary knee joint replacement with a total endoprosthesis (cruciate-retaining implant with patellar resurfacing) between 2020 and 2024. All procedures involved tibially fixed polyethylene inserts with preservation of the posterior cruciate ligament (Fa. Aesculap). Patients selected for inclusion were those diagnosed with stage III–IV gonarthrosis according to the Kellgren & Lawrence classification. and radiological evaluations were performed preoperatively, at hospital discharge, and at 6 weeks and 6 months postoperatively.

Patients were divided into two main groups:

- **N-group:** Patients who underwent computer-assisted total knee arthroplasty with patellar resurfacing using a navigation system (OrthoPilot®, Fa. B. Braun, Aesculap).
- **S-group:** Patients who underwent standard (non-navigated) total knee arthroplasty with patellar resurfacing.

Age subgroups:

- **Group I:** 50 to 65 years
- **Group II:** 66 to 80 years

Gender distribution:

- **M:** male
- **F:** female

The study consisted of 100 patients (50 female, 50 male) who underwent primary total knee replacement with patellar resurfacing between 2020 and 2024. Of these, 50 patients were assigned to the N-group (25 female / 25 male) undergoing computer-assisted navigation, and 50 patients to the S-group (25 female / 25 male) undergoing the standard technique.

Results.

Pre- and postoperative radiographic evaluations were performed, including anteroposterior (A.P.) and lateral views of the knee joint, as well as full-length, weight-bearing anteroposterior radiographs of the entire lower limb. Pain assessment was conducted pre- and postoperatively using the Numerical Rating Scale (NRS) ranging from 0 to 10.

Following hospital discharge, all patients underwent a complete rehabilitation program, which included early mechanotherapy, physiotherapy, lymphatic drainage, manual therapy, and therapeutic exercises. Particular emphasis was placed on strengthening the muscular apparatus (M. quadriceps femoris, M. gastrocnemius, ischiocrural muscles/hamstrings) and enhancing the stability of the knee joint.

No significant differences were observed in outcomes based on age or sex. Analysis of knee flexion range revealed that, preoperatively, the mean flexion in the computer-assisted surgery group (N) was M = 109.70°, SD = 10.32, while in the conventional surgery group (S) it was M = 104.40°, SD = 10.48.

On postoperative day 5, both groups experienced a marked reduction in flexion amplitude (N: M = 58.70°, SD = 15.28; S:

M = 46.00°, SD = 11.07). Subsequent assessments showed a clear trend of recovery. By 6 weeks postoperatively, the mean flexion had increased to M = 119.40°, SD = 6.97 in the N group and M = 110.00°, SD = 9.04 in the S group.

At 6 months postoperatively, both groups reached their maximal flexion, although the computer-assisted group (N) maintained a higher range of knee flexion (N: M = 121.00°, SD = 7.00; S: M = 113.40°, SD = 8.48).

Regarding postoperative pain during days 4–5, mild pain was reported in 38% of patients in the N group and 26% in the S group. Moderate pain was observed in 48% of N group patients and 52% of S group patients, while severe pain occurred in 14% of N group patients and 22% of S group patients.

By 6 weeks postoperatively, 46.0% of patients in the computer-assisted group (N) reported no pain, 40.0% mild pain, 12.0% moderate pain, and only 2.0% severe pain. In the conventional surgery group (S), 30.0% were pain-free, 40.0% reported mild pain, 28.0% moderate pain, and 2.0% severe pain (Figure 1).

Discussion.

Since pain-level variables represent ordinal data—where each category reflects the severity of pain within defined intervals (0 = no pain, 1 = mild, 2 = moderate, 3 = severe pain)—a Crosstab Analysis was employed to evaluate the association between the type of surgery (computer-assisted navigation vs. standard technique) and pain-level categories. Kendall's tau-b coefficient was used to determine the direction and strength of the association, while standardized residual statistics were applied to identify differences between groups.

In the preoperative period, 22.0% of patients who underwent computer-assisted navigated surgery reported moderate pain, whereas 78.0% reported severe pain. Among patients treated with the traditional method, moderate pain was observed in 26.0%, and severe pain in 74.0%. The residual coefficients indicate that preoperative pain perception did not significantly differ between the N and S groups (P > .05), suggesting that the groups were homogeneous at baseline.

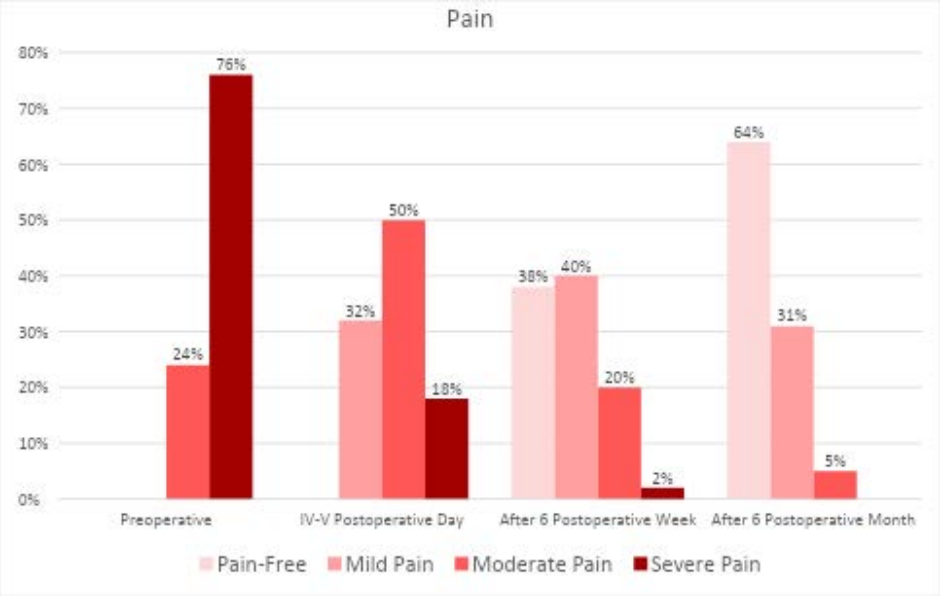

Figure 1. *Pain.*

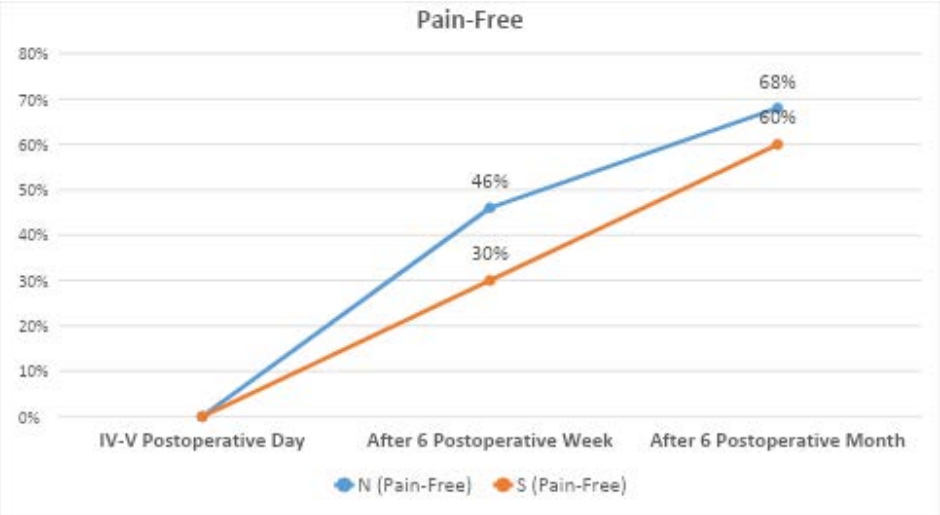

Figure 2. *Pain-free Patients.*

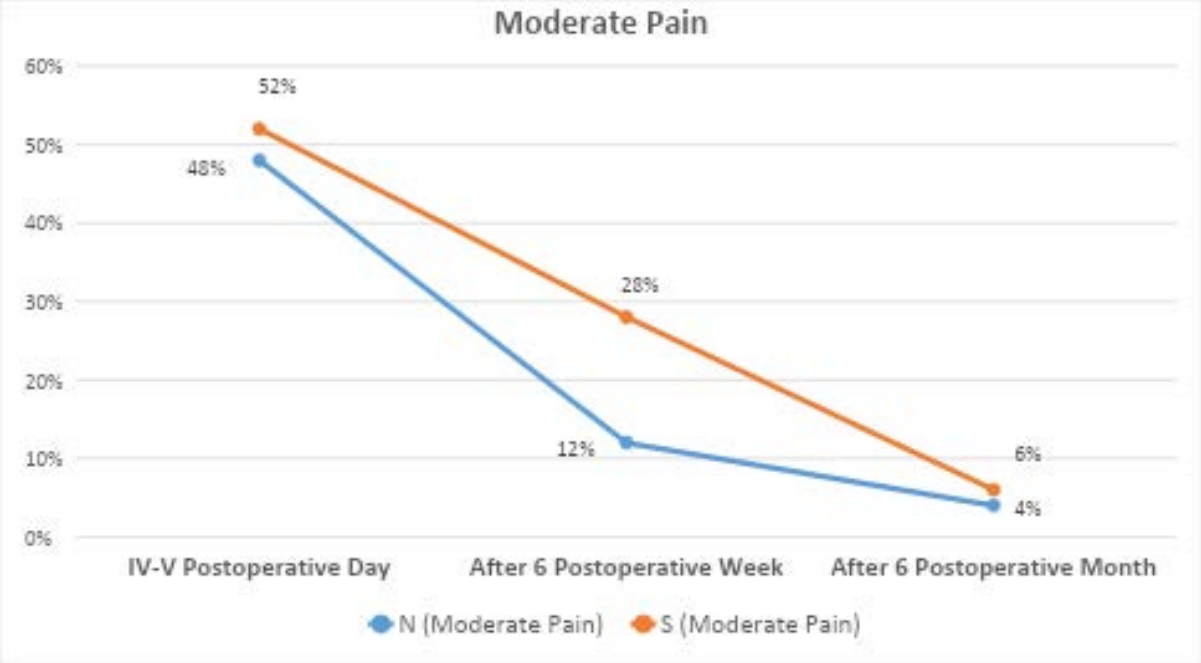

Figure 3. *Patients with moderate pain.*

It is noteworthy that during the early postoperative period (days 4–5), pain perception did not significantly differ between the combined N and S groups ($P > .05$). However, an important trend was observed: severe pain occurred more frequently in the S group, whereas mild pain was more common among patients in the N group (Figures 2 and 3).

In this study, the primary objective was to evaluate the dynamics of knee flexion amplitude changes over different time points—preoperatively, and at 5 days, 6 weeks, and 6 months postoperatively—and to compare these changes between two surgical techniques: computer-navigated surgery and conventional standard surgery. To achieve this, a repeated measures ANOVA was employed, allowing simultaneous assessment of:

- The effect of time on knee flexion amplitude,
- The effect of surgical technique, and
- The interaction between time and surgical technique.

Multivariate analysis indicated that knee flexion amplitude significantly changed over time (Pillai's Trace = 0.966, Wilks' Lambda = 0.034, $F(3,96) = 902.062$, $p < 0.001$). Furthermore, the interaction between time and surgical group was statistically significant (Amplitudes × Group: $F(3,96) = 3.458$, $p = 0.019$), suggesting that the rate of knee flexion recovery differs between the groups. Specifically, patients who underwent computer-navigated surgery demonstrated a faster and more complete recovery of knee flexion amplitude in the postoperative period compared to those who underwent conventional surgery. The significant interaction effect confirms that the type of surgical procedure influences the recovery dynamics [21-29].

Conclusion.

At the sixth postoperative week, 16% more patients in the computer-navigated surgery group (N) achieved a pain-free state compared to the conventional surgery group (S). Conversely, moderate pain was observed 16% more frequently in the conventional surgery group than in the navigated surgery group. Analysis of standardized residuals indicated that in the N group, the residual for the pain-free category was positive (0.9), whereas for the moderate pain category it was negative (-1.3), suggesting that pain-free status occurred more frequently, and moderate pain less frequently, than expected. In contrast, the S group showed the opposite trend, with moderate pain observed more frequently than expected and pain-free status less frequently.

Kendall's tau-b correlation confirmed a weak but statistically significant association between surgical technique and postoperative pain ($\tau b = 0.193$, $p = 0.035$), indicating a tendency for computer-navigated surgery to be associated with lower postoperative pain at 6 weeks.

By the sixth postoperative month, 68% of patients in the N group were pain-free, 28% reported mild pain, and 4% moderate pain. In the S group, 60% were pain-free, 34% reported mild pain, and 6% moderate pain. Although the percentage differences between groups were not statistically significant ($p > 0.05$), a slightly higher proportion of N group patients (8%) achieved pain-free status compared to the S group.

Comparative analysis of knee flexion amplitude across the four time points revealed a significant difference between groups ($F = 31.343$, $p < 0.001$). Overall, patients who underwent computer-navigated surgery consistently demonstrated higher knee flexion amplitudes compared to those in the conventional surgery group. Notably, the difference between groups became more pronounced over time, particularly from 6 weeks to 6 months postoperatively.

REFERENCES

1. Alvarez PM, McKeon JF, Spitzer AI, et al. Socioeconomic factors affecting outcomes in total knee and hip arthroplasty: a systematic review on healthcare disparities. Art Ther. 2022;4:36.

2. Batailler C, Swan J, Sappey Marinier E, et al. New Technologies in Knee Arthroplasty: current concepts. J Clin Med. 2020;10:47.
3. Cantivalli A, Cottino U, Bonasia DE, et al. Robotic Systems in Knee Surgery: current concepts and future perspectives. Prosthesis. 2023;5:1257-1274.
4. Christen B, Tanner L, Ettinger M, et al. Comparative cost analysis of four different computer-assisted technologies to implant a Total knee arthroplasty over conventional instrumentation. J Pers Med. 2022;12:184.
5. Cozzi Lepri A, Innocenti M, Matassi F, et al. Accelerometer-based navigation in Total knee arthroplasty for the Management of Extra-Articular Deformity and Retained Femoral Hardware: analysis of component alignment. Joints. 2019;7:1-7.
6. Deep K, Shankar S, Mahendra A. Computer assisted navigation in total knee and hip arthroplasty. Sicot J. 2017;3:50.
7. Dong Z, Li Y, Tian H. Research progress on comparison of the application effects between personal specific instrumentation and computer-assisted navigation surgery in total knee arthroplasty. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2021;35:1492-1498.
8. Figueroa F, Parker D, Fritsch B, et al. New and evolving technologies for knee arthroplasty—computer navigation and robotics: state of the art. J ISAKOS. 2018;3:46-54.
9. Gong S, Xu W, Wang R, et al. Patient-specific instrumentation improved axial alignment of the femoral component, operative time and perioperative blood loss after total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2019;27:1083-1095.
10. Gordon AC, Conditt MA, Verstraete MA. Achieving a balanced knee in robotic TKA. Sensors (Basel). 2021;21:535.
11. Hariri M, Hagemann M, Mick P, et al. Physical activity of young patients following minimally invasive lateral Unicompartmental knee replacement. J Clin Med. 2023;12:635.
12. Hill D, Williamson T, Lai CY, et al. Robots and tools for remodeling bone. IEEE Rev Biomed Eng. 2020;13:184-198.
13. Hinloopen JH, Puijk R, Nolte PA, et al. The efficacy and safety of patient-specific instrumentation in primary total knee replacement: a systematic review and meta-analysis. Expert Rev Med Devices. 2023;20:245-252.
14. Marullo M, Vitale JA, Stucovitz E, et al. Simultaneous bilateral unicompartmental knee replacement improves gait parameters in patients with bilateral knee osteoarthritis. Knee. 2019;26:1413-1420.
15. Matassi F, Cozzi Lepri A, Innocenti M, et al. Total knee arthroplasty in patients with extra-articular deformity: restoration of mechanical alignment using accelerometer-based navigation system. J Arthroplasty. 2019;34:676-681.
16. Matsumoto T, Nakano N, Hayashi S, et al. Prosthetic orientation, limb alignment, and soft tissue balance with bi-cruciate stabilized total knee arthroplasty: a comparison between the handheld robot and conventional techniques. Int Orthop. 2023;47:1473-1480.
17. Nandi M, Schreiber KL, Martel MO, et al. Sex differences in negative affect and postoperative pain in patients undergoing total knee arthroplasty. Biol Sex Differ. 2019;10:23.
18. Nisar S, Palan J, Rivière C, et al. Kinematic alignment in total knee arthroplasty. EFORT Open Rev. 2020;5:380-390.
19. Odum SM, Fehring TKG. Knee Society Crosswalk Writing. Can original knee society scores Be used to estimate new 2011 knee society scores? Clin Orthop Relat Res. 2017;475:160-167.
20. Pietsch M, Hochegger M, Djahani O, et al. Handheld computer-navigated constrained total knee arthroplasty for complex extra-articular deformities. Arch Orthop Trauma Surg. 2021;141:2245-2254.
21. Sculco PK, Kahlenberg CA, Fragomen AT, et al. Management of Extra-articular Deformity in the setting of Total knee arthroplasty. J Am Acad Orthop Surg. 2019;27:e819-e830.
22. Shah SM. After 25 years of computer-navigated total knee arthroplasty, where do we stand today? Art Ther. 2021;3:41.
23. Shakya P, Poudel S. Prehabilitation in patients before major surgery: a review article. J Nepal Med Assoc. 2022;60:909-915.
24. Shatrov J, Parker D. Computer and robotic - assisted total knee arthroplasty: a review of outcomes. J Exp Orthop. 2020;7:70.
25. Shih YC, Chau MM, Arendt EA, et al. Measuring lower extremity rotational alignment: a review of methods and case studies of clinical applications. J Bone Joint Surg Am. 2020;102:343-356.
26. Siddiqi A, Horan T, Molloy RM, et al. A clinical review of robotic navigation in total knee arthroplasty: historical systems to modern design. EFORT Open Rev. 2021;6:252-269.
27. Wan RCW, Fan JCH, Hung YW, et al. Cost, safety, and rehabilitation of same-stage, bilateral total knee replacements compared to two-stage total knee replacements. Knee Surg Relat Res. 2021;33:17.
28. Wang B, Xing D, Li JJ, et al. Lateral or medial approach for valgus knee in total knee arthroplasty - which one is better? A systematic review. J Int Med Res. 2019;47:5400-5413.
29. Weber P, Gollwitzer H. Kinematic alignment in total knee arthroplasty. Oper Orthop Traumatol. 2021;33:525-537.