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Journal of Urban Medicine**



ABOUT THE JOURNAL

The Journal of Medicine and Urban Health (JMUH) is an international, peer-reviewed, open-access scholarly publication sponsored by Faculty of Medicine Vajira Hospital, Navamindradhiraj University, Thailand. The primary mission of JMUH is to advance medical knowledge, elevate healthcare standards, and address complex diseases and health issues affecting human populations, with a particular emphasis on the unique challenges presented by urban living environments. JMUH provides a vital platform for interdisciplinary collaboration among physicians, medical specialists, basic science researchers, and public health professionals worldwide.

AIMS & SCOPE

JMUH publishes innovative, evidence-based research that bridges fundamental biomedical discoveries, bedside clinical management, and population-level health solutions. The journal welcomes scholarly contributions that elucidate disease etiologies, evaluate novel diagnostic and therapeutic interventions, optimize clinical outcomes, and address health system dynamics in urban environments. Our scope encompasses, but is not limited to, the following five primary categories:

1. Clinical Medicine and Medical Subspecialties

- Comprehensive diagnostic, therapeutic, and clinical outcome studies across internal medicine subspecialties, including cardiology, neurology, dermatology, nephrology, gastroenterology, hepatology, infectious diseases, and endocrinology.
- Clinical epidemiology, pathogenesis, and management of acute/chronic infectious diseases, including long COVID determinants, emerging urban pathogens, and unusual clinical case reports.

2. Surgical Sciences, Anesthesiology, and Perioperative Care

- Innovations and clinical outcomes in general surgery, orthopedic surgery, orthopedic trauma, urology, otolaryngology, and surgical oncology.
- Advancements in anesthesiology, anesthesia optimization, perioperative safety, airway management, surgical blood conservation protocols, and resource optimization in high-volume urban medical centers.

3. Maternal, Pediatric, and Reproductive Medicine

- Neonatal intensive care strategies, low birth weight infant outcomes, infantile vitamin D supplementation, pediatric long COVID, child development, and pediatric outcomes in urban populations.
- Obstetrics and gynecological care, gestational diabetes mellitus management, postpartum hemorrhage prevention, postpartum family planning, and maternal health access in resource-constrained or high-density care settings.

4. Translational, Basic, Molecular, and Diagnostic Sciences

- Translational medicine and biomedical research, including biomarker discovery, pharmacogenetics, precision medicine, and clinically oriented biomedical research.
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- Palliative care, advance care planning, spiritual well-being, behavioral nutrition, nursing care, physical therapy, and complementary integrative medicine.

JOURNAL HISTORY

The Journal of Medicine and Urban Health (JMUH; online ISSN 3088-2834, print ISSN 3088-2826) continues the nearly 70-year legacy of the Vajira Medical Journal, established in 1957 and renamed the Vajira Medical Journal: Journal of Urban Medicine in 2016. Founded by Passakorn Kasemsuwan, MD, and 20 editorial board members, the journal has contributed to the academic reputation and professional development of faculty and researchers. Over time, its editorial board expanded to include national members from various institutions across Thailand, providing active support to researchers both within and outside the faculty nationwide.

Since October 2021, JMUH has recruited exclusively manuscripts in English. Under the editor-in-chief Jitti Hanprasertpong, MD, since 2023, the publication frequency was changed from bimonthly to quarterly, with 7–8 articles per issue. In 2025, the journal was recognized as a Tier 1 journal by the Thai-Journal Citation Index. In 2026, it adopted its current name, the Journal of Medicine and Urban Health (JMUH), as part of its transition toward greater internationalization, supported by an expanded national and international editorial board, national and international reviewers, and national and international authors.

JOURNAL DIRECTION

Building on the legacy of the Vajira Medical Journal, which later became the Vajira Medical Journal: Journal of Urban Medicine, JMUH serves as a scholarly bridge connecting Thai and international researchers. JMUH publishes high-quality, peer-reviewed research across five core disciplines: clinical medicine and subspecialties; surgical sciences, anesthesiology, and perioperative care; maternal, pediatric, and reproductive medicine; translational, basic, molecular, and diagnostic sciences; and preventive medicine, public health, and integrated care.

The journal advances medical science and public health practice by addressing contemporary health challenges, with a dedicated emphasis on urban environments. JMUH promotes research that informs clinical care, shapes public health policy, and improves outcomes in rapidly urbanizing societies. Guided by a distinguished international editorial board, JMUH maintains rigorous peer-review standards and actively fosters global scholarly engagement.

Looking ahead, JMUH aspires to expand its global visibility and academic impact, aiming for inclusion in Scopus and other major international indexing databases to ensure the broad dissemination and recognition of its authors' contributions.

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Manuscripts must not be under consideration for publication in another journal. Authors should ensure that their manuscript adheres to the Journal of Medicine and Urban Health (JMUH)'s guidelines before submission. JMUH recommends that authors adhere to the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals developed by the International Committee of Medical Journal Editors (ICMJE) (the latest version).

In addition, authors should prepare manuscripts in accordance with the following guidelines, as appropriate to the study design:

- CONSORT for randomized controlled trials
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- STARD for diagnostic accuracy studies
- TRIPOD or TRIPOD-AI for prediction model studies
- CHEERS for economic evaluation studies
- PRISMA for systematic reviews and meta-analyses
- ARRIVE for experimental animal studies
- TREND for non-randomized behavioral and public health interventions
- CARE for case reports

The corresponding author must submit the manuscript on behalf of all authors. All submissions will be screened for inappropriate use of previously published material. Manuscripts should adhere to length restrictions and be written in clear, concise English with sufficient methodological detail for reproducibility. JMUH reserves the right to edit manuscripts for grammar, style, and clarity during the editorial process.

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Special articles are invited by the editor-in-chief and provide expert overviews or perspectives on significant medical and health topics. They should summarize current knowledge, highlight emerging concepts, and offer guidance for future research or clinical practice. Special articles should include the following sections: Abstract, Introduction, Content of Review, Conclusion, Conflict of Interest, Acknowledgments, Author Contributions, and References. The main text should be 1,500–2,500 words. References should not exceed 25. Tables and figures should not exceed 6 in total.

2. Original Article or Systematic Review and Meta-Analysis

Original articles should present novel research findings that have not been published elsewhere and contribute new knowledge or insights, such as innovative methodologies or clinically significant outcomes, rather than simply confirming previous work. They must use rigorous, reproducible methods with appropriate ethical approval and be clearly structured, including a concise abstract, detailed methods, coherent results, and a balanced discussion with limitations addressed. Original articles should include the following sections: Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusion, Conflict of Interest, Acknowledgments, Author Contributions, Data Availability Statement, and References. The main text should be 2,500–3,500 words. References should not exceed 40. Tables and figures should not exceed 8 in total.

Systematic reviews and meta-analyses should provide a comprehensive, structured synthesis of existing evidence on a specific clinical or scientific question, adhering to international guidelines such as the PRISMA statement. They must include a transparent and reproducible methodology, with a clearly defined search strategy, inclusion/exclusion criteria, and quality assessment of included studies. Meta-analyses should apply appropriate statistical methods to quantitatively synthesize results, report heterogeneity, and assess potential

bias. Systematic reviews and meta-analyses should include the following sections: Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusion, Conflict of Interest, Acknowledgments, Author Contributions, Data Availability Statement, and References. The main text should be 3,000–4,500 words. References should not exceed 100. Tables and figures should not exceed 10 in total.

3. Review Article

Review articles critically evaluate and synthesize recent studies on a specific topic to provide readers with a comprehensive understanding. They should analyze the literature in depth, compare strategies and methodologies, highlight gaps and future research directions, and present a well-structured overview. While not all studies need to be included, all relevant and significant works should be addressed. Review articles should include the following sections: Abstract, Introduction, Content of Review, Conclusion, Conflict of Interest, Acknowledgments, Author Contributions, and References. The main text should be 2,500–3,500 words. References should range from 40–100. Tables and figures should have 8–10 in total.

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Case reports describe the symptoms, diagnosis, treatment, and follow-up of individual patients, typically focusing on unique or rare clinical occurrences. They should provide insights into unusual presentations, novel therapeutic approaches, or clinically relevant lessons that may generate new hypotheses in medicine. Reports must be clearly written, ethically sound, and supported by patient consent. Relevant literature should be cited to contextualize the case. Tables, figures, and images should be used judiciously to illustrate key findings. Case reports should include the following sections: Abstract, Introduction, Case Report, Discussion, Conclusion, Conflict of Interest, Acknowledgments, Author Contributions, and References. The main text should be 1,500–2,500 words. References should not exceed 25. Tables and figures should not exceed 6 in total.

MANUSCRIPT PREPARATION

Prior to your submission, please ensure that your manuscript has been prepared according to the guidelines below.

1) Submission Method

Manuscript must be submitted through ScholarOne online submission system, which is accessible via ScholarOne link.

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The following checklist will be useful during the final checking of a manuscript prior to submitting it to the journal for review.

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A cover letter must include the name and title of the corresponding author, full address, telephone number, and e-mail address, as well as the title and category of the submitted manuscript (e.g., Special Article, Original Article, Systematic Reviews and Meta-Analyses, Review Article, and Case Report). The cover letter should provide a brief summary (2–3 sentences) highlighting the main findings, novelty, and clinical/scientific relevance of the work. The letter should also contain a declaration stating that the manuscript has been read and approved by all authors regarding its content and accuracy, and that the manuscript has not been previously published and is not under consideration for publication elsewhere. Finally, the cover letter must be dated and signed (handwritten or authorized electronic signature) by the corresponding author on behalf of all co-authors.

4) Reviewer Suggestions

We ask authors to suggest at least two potential reviewers, who possess relevant expertise and a proven publication record in the field of the submitted work, when submitting their manuscript. Opposed reviewers are optional for authors. Bear in mind any potential competing interests when making these suggestions. It is not appropriate to suggest recent collaborators or other researchers at your own institution.

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- The document shall be formatted using Times New Roman, 12-point font, with double spacing and justified alignment.
- The first line of each new paragraph shall be indented using a single tab, beginning with the second paragraph under each heading.
- Page breaks or multiple returns between sections shall not be used; each section shall directly follow the preceding section on the page.
- Page numbers and continuous line numbers shall be inserted throughout the document.
- General headings (main headings) shall be presented in uppercase letters.
- Subtitles shall be presented in Title Case, with the first letter of all principal words, including the first word, capitalized, while prepositions, articles, and coordinating conjunctions shall remain in lowercase.
- Abbreviations shall be written out in full upon first use, followed by the abbreviation in parentheses. The abbreviation shall be used thereafter. Abbreviations shall not be used in titles, headings, abstracts, or references. The abbreviation lists used in the abstract and the main text shall be considered independent of each other.

6) Title Page Requirements

All manuscripts must contain a title page that includes all of the following information.

- The title of the manuscript shall be presented in sentence case and shall not contain abbreviations unless they are standard accepted.
- The running title shall not exceed 60 characters.
- The full names of all authors, all academic degrees, and the full affiliations of all authors, including their complete postal addresses, shall be provided.
- Author affiliations shall be indicated using superscript numbers.
- The corresponding author's name and e-mail address must be included.
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Original articles must contain all of the following sections:

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- **Data Availability Statement:** JMUH follows the ICMJE Recommendations for Data Sharing. All manuscripts reporting original research, systematic reviews and meta-analyses must include a Data Availability Statement in accordance with these guidelines. Authors should provide a statement describing the availability of the research data and analytic materials (e.g., code, software, or study protocols) supporting the study, including where they can be accessed and, where applicable, any conditions or restrictions on access. If the data or materials are not publicly available, authors should state the reason and indicate how qualified researchers may request access, where possible. Data sharing is subject to applicable ethical, legal, and privacy requirements.
- **References:** This section should be put after the main text. The citations in the text, tables, and descriptions should be listed in the order they are reference to in the text using superscript Arabic numbers without parentheses after periods, commas, and quotation marks, but before colons, and semicolons. For example, use superscript Arabic numbers after periods.¹ Use superscript Arabic numbers after commas,². Moreover, the abbreviation “et al.”, place superscript Arabic outside the period et al.⁵ References should be formatted in the “**Vancouver style**”.

Examples:

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Cite figures in the text in ascending numeric order at first appearance in the manuscript file. For example, Figure 1, Figure 2 and so on. Figure is required for an abbreviated summary of the figure specifications.

File Format	TIFF, JPEG, PNG
Resolution	300–600 dpi
File size	< 10 MB
Figure files	Figure 1.tif, Figure 2.jpeg and so on. Match filename to legend and citation.
Legends	Figure 1. XXX, Figure 2. XXX and so on. Make sure that legends are matched with filenames.

Figure Files

- Use Times New Roman font in all illustrations.
- Use consistent lettering, font size, and formatting throughout all figures.
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- Ensure that each figure is of sufficient resolution and quality for publication.

Please do not:

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Each figure must have a corresponding legend. Figure legends should be provided separately from the figure files and should not be embedded in or attached to the figures.

Each legend should include a brief title and a clear description of the figure. The title should not be included within the figure itself. Keep text within the figures to a minimum, and explain all symbols, abbreviations, and other relevant elements used in the figure in the legend. Figure legends should be formatted in Times New Roman, 12-point font size.

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Cite tables in ascending numeric order upon first appearance in the manuscript file. All tables and their titles must be placed at the end of manuscript after the reference list.

Tables require a label (e.g., "Table 1") and brief descriptive title to be placed above the table. Use Times New Roman in 12-point font size. Place legends, footnotes, and other text below the table. To mark each footnote, use superscript letter (a, b, c). All abbreviations appearing in the table must be listed alphabetically.

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Jitti Hanprasertpong

SPECIAL ARTICLE

Bangkok's Emerging Health Megacenter: Opportunities and Implications for Thailand's Healthcare Future

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ABSTRACT

Bangkok is increasingly developing into a health megacenter characterized by the geographic concentration and functional integration of academic medical centers, private hospital networks, government specialist institutions, research and educational organizations, biomedical industries, and wellness enterprises. This transformation is being driven by demographic aging, medical tourism, geopolitical mobility, biomedical innovation, government incentives, and the rapid expansion of wellness and longevity markets.

The emerging megacenter offers important opportunities for economic growth, regional competitiveness, biomedical innovation, and the development of high-value health services. However, it also creates substantial health-system risks. Competition for specialist personnel may intensify the internal migration of physicians, nurses, and other health professionals toward Bangkok and premium-service institutions, thereby worsening existing geographic disparities. At the same time, competition in advanced technologies and specialized care may contribute to medical inflation, particularly when adoption occurs without sufficient evidence of population-level benefit. The growing convergence of healthcare and wellness may further expand healthcare consumption through the medicalization of aging, risk, and preventive health management.

Bangkok's health megacenter therefore represents a policy paradox: it may strengthen Thailand's position as a regional medical and wellness hub while placing additional pressure on the equity and sustainability of universal health coverage. Realizing its benefits while limiting adverse consequences will require coordinated governance, including workforce-retention strategies, health technology assessment, appropriate financing and cross-subsidization mechanisms, support for domestic biomedical innovation, and integration of health policy with urban planning.

Keywords: Bangkok, health equity, health megacenter, health workforce, medical tourism, universal health coverage

INTRODUCTION

Bangkok has long been the political, economic, and transportation center of Thailand, with a current registered population of 5.4 million.¹ At the same time, the city continues to attract migrants from other provinces, expatriate professionals, international retirees, and medical travelers from across Asia and beyond. The estimated actual population of the Bangkok Metropolitan Area is around twice its official number.² Recently, Bangkok has undergone another transformation that receives far less public attention. In the wake of global demographic shifts and a growing post-pandemic interest in longevity and preventive health, this city is rapidly consolidating its status as a premier 'Medical Hub' through ambitious health megaclusters. This evolution is driven by a convergence of interests among established academic institutions and private healthcare conglomerates that are pivoting toward the global growth of the wellness market. In this article, the term health megacluster refers to the geographic concentration and functional integration of healthcare providers, research institutions, educational organizations, biomedical industries, and wellness enterprises within a major metropolitan region. While these developments capitalize on Thailand's geopolitical advantages and clinical excellence, they also raise critical questions about the domestic healthcare landscape. These converging trends suggest that Bangkok is evolving into a health megacluster, a dense concentration of healthcare megaprojects, research and educational institutes, and wellness enterprises that may have profound implications not only for the city's economy but also for the future direction of Thailand's healthcare system.

CONTENT OF REVIEW

Bangkok as an Emerging Regional Health Hub

Bangkok has served as Thailand's health capital in both service and academic aspects. Of the hospitals in Bangkok in 2017, 5 were medical school hospitals, 18 were specialized hospitals, 26 were general hospitals, and 108 were hospitals run by private investors.³ Physician density in Bangkok was approximately 1.59 physicians per 1,000 registered population, compared with 0.54 per 1,000 nationally.³ Under the Department of Medical Services of the Ministry of Public Health, major tertiary and specialized institutions in Bangkok include Rajavithi Hospital, Lerdsin Hospital, Nopparat Rajathanee Hospital, the National Cancer Institute, and the Queen Sirikit National Institute of Child Health. Official Department of Medical Services data indicate

that these institutions collectively account for more than 2,600 operational inpatient beds, although the corresponding authorized capacity is higher.⁴ The Bangkok Metropolitan Administration's Medical Service Department operates 12 hospitals across the city.⁵ Its fiscal year 2024 statistical report documented a combined capacity of 2,808 inpatient beds as of 30 September 2024, although two recently established facilities were providing outpatient services only at that time.⁶ The network continues to expand through the opening of inpatient units and the development of additional hospital facilities.⁷ Medical schools in Bangkok, under the Ministry of Higher Education, Science, Research and Innovation, are major stakeholders in the city's health system. Chulalongkorn Hospital, Siriraj Hospital, and Ramathibodi Hospital are three major academic medical centers of high-level care in the public sector. Apart from providing complex care, these centers serve as frontline adopters of medical technology. Siriraj has recently expanded its capacity to the nearby premium-service facility, Siriraj Piyamaharajkarun, and plans another high-end center in Bang Pho, Siriraj International Medical Center (SI NEXT), a government-approved international medical project scheduled for implementation during 2026–2031, with a total planned investment of approximately (Thai Baht) THB 16.96 billion (Table 1).^{8,9} Ramathibodi has successfully operated Somdech Phra Debaratana Medical Center in a separate building and is now beginning to operate a private-style, lightweight center nearby, Ramathibodi Sri Ayutthaya Medical Center, a preventive, specialist, and premium-service facility. Its original design brief proposed at least 26,000 m² of floor area, a preliminary construction budget of THB 900 million excluding equipment, and capacity to accommodate approximately 2,500 users per day.¹⁰ Ramathibodi is also planning a large-scale medical and innovation complex across the street, the Yothi Medical Innovation District, a wider medical and innovation ecosystem covering approximately 1.7 million m² and bringing together healthcare, educational, research, governmental, and private-sector organizations. Within this district, Ramathibodi began construction of a major new hospital-building project in December 2025, with completion expected in 2031.^{11,12} In June 2026, the Department of Medical Services commenced the development of a new National Cancer Institute branch in Bang Khun Thian. The THB 3.285-billion project is scheduled for 2026–2031 and is planned to include 95 outpatient examination rooms, four radiotherapy units,

Table 1 Major Health and Biomedical Developments Contributing to Bangkok's Emerging Health Megacenter

Institution/Project	Sector	Principal Function	Reported Capacity or Investment	Status as of 2026
SI NEXT	Public academic/premium service	International and specialized care	A total planned investment of approximately THB 16.96 billion	Scheduled for implementation during 2026–2031
Ramathibodi Medical Center	Public academic	At least 26,000 m ² of building area for ambulatory, preventive and premium services	A preliminary construction budget of THB 900 million (excluding equipment)	Operational/partially operational
Yothi Medical District	Public/academic innovation	Approximately 1.7 million m ² , containing research, education, biomedical innovation	A total investment plan of THB 11,629 million	Completion expected in 2031
NCI Bang Khun Thien project	Public specialized hospital	Cancer care, including 95 outpatient examination rooms, four radiotherapy units, advanced diagnostic and treatment centers, and 200 inpatient beds	A total budget of THB 3.285 billion	Under development, from 2026–2031
RSU International Hospital	Private academic	International quaternary care, 282-bed, 21-storey medical center with approximately 87,649 m ² of usable area	A total project value of THB 8.643	Completion expected in 2027
WellEra Bangkok, BDMS	Private healthcare and mixed-use wellness	Preventive medicine, wellness residences, urban retreat, hospitality, and lifestyle retail	> THB 29 billion; approximately 13 rai; 262 Capella-branded residences	Under development; full opening planned for 2030

Abbreviations: BDMS, Bangkok Dusit Medical Services; m², square meter; NCI, National Cancer Institute; RSU, Rangsit University; SI NEXT, Siriraj International Medical Center; THB, Thai Baht

advanced diagnostic and treatment centers, and 200 inpatient beds.¹³ Rangsit University, a private university with its own Faculty of Medicine, is developing Arthit International Hospital, previously announced as RSU International Hospital.¹⁴ The original project plan described a 282-bed, 21-storey medical center with approximately 87,649 m² of usable area and an estimated project value of THB 8.643 billion. The hospital was publicly launched under its current name in February 2026.¹⁵ Concurrent with the leap into the business of old academic power, huge private investment is expanding into the wellness market, a rapidly expanding segment of economic activity born in the post-pandemic period. A particularly prominent private-sector development is WellEra Bangkok. In June 2026, Bangkok Dusit Medical Services (BDMS) group announced an investment of more than THB 29 billion in the development in the heart of Bangkok, scheduled to open fully in 2030. The project combines a preventive-medicine and scientific-wellness clinic, wellness-oriented residences, an urban wellness retreat, and lifestyle retail within a single mixed-use ecosystem. The project illustrates the growing convergence of medical care, preventive health services, luxury hospitality, residential property, and lifestyle consumption within Bangkok's emerging health megacenter.^{16,17} The private health sector is now the frontline player in health technology adoption, with timely investment in new technologies such as genomic medicine and advanced therapeutic medical products. The phenomenon of the increasing convergence of academic and private healthcare investment raises a big question: what economic forces are accelerating this growth, and where is the region's healthcare climate heading?

Several converging factors explain this aggressive pivot toward wellness and high-end medical clusters. Globally, the post-pandemic era has catalyzed a shift from reactive 'sick-care' to proactive 'longevity management,' a market segment that remains remarkably resilient to economic downturns. Regionally, Thailand is strategically leveraging its geopolitical position to capture the 'Silver Economy' of an aging East Asia and the rising affluent class of the Middle East, both of whom seek world-class therapeutic outcomes at a competitive price point. Regional geopolitical instability and cross-border mobility may alter the composition of healthcare demand in Bangkok, although the scale and long-term implications remain uncertain. Domestically, some of these projects are bolstered by the Thai government, particularly through the Thailand Science Research and

Innovation grant and Board of Investment incentives, which aim to transform Thailand into a high-tech biomedical hub. The term 'Medical Hub' has appeared in Thailand's 20-Year National Strategy since 2018.¹⁸ On the supply side, Thailand has long-term experience in the health care industry, and Bangkok has a competitive advantage in manpower in this sector. However, this economic optimism is shadowed by a significant structural concern: the 'internal brain drain.' As these megacenters proliferate, they threaten to draw highly specialized clinicians and nursing staff away from the resource-strained public sector, potentially inflating the cost of care and widening the equity gap within the nation's celebrated Universal Coverage Scheme.

The institutional examples presented in this article were identified from publicly available government planning documents, institutional annual reports, official project announcements, and organizational websites. Project status, reported capacity, and investment figures were verified against the most recent publicly available information as of May 2026; the examples are illustrative rather than exhaustive.

Workforce Implications and Internal Brain Drain

Although at the country level, Thai medical schools produce at least 3,500 new doctors each year, and the number of new medical schools is increasing, the distribution of physicians per capita is determined by economic leverage in each area. Thailand's physician workforce has historically been characterized by marked geographic maldistribution rather than an absolute national shortage.¹⁹ As early as 2004, approximately 39.6% of all physicians were concentrated in the Bangkok metropolitan area, yielding a contrast between an estimated ratio of one physician per 800 people in Bangkok and one per 5,700 in some rural northeastern provinces.²⁰ Longitudinal analyses confirmed that, although inequality indices improved over the subsequent decade, with the Gini coefficient for physician distribution declining from 0.372 in 2008 to 0.319 in 2018,²¹ Bangkok remained the only province to have consistently met the Ministry of Public Health target of one physician per 1,800 population, while numerous provinces continued to fall short.²² A cohort-based projection published in 2013 estimated that Thailand's physician workforce could exceed 60,000 by the late 2020s; however, the authors anticipated that geographic maldistribution would persist.²³ Against this structural backdrop, the rapid proliferation of health megaprojects in Bangkok introduces

an additional centripetal force. The expansion of high-end private and academic medical centers intensifies market competition for specialist physicians, accelerating the well-documented internal brain drain, the migration of clinicians from rural public facilities to urban private institutions.²⁴ Although targeted initiatives such as the Collaborative Project to Increase Rural Doctors have demonstrated meaningful improvements in rural retention, with special-track graduates showing approximately a 2.4-fold greater likelihood of remaining in Ministry of Public Health service for three or more years compared with conventional graduates,^{25,26} these gains remain fragile in the face of widening urban–rural salary differentials and the prestige economy cultivated by emerging health megaclusters. The convergence of megaproject-driven demand and an already skewed distribution of physicians therefore risks compounding inequity within Thailand's Universal Coverage Scheme, redirecting a disproportionate share of the nation's most experienced clinicians toward premium care markets while resource-constrained provincial hospitals continue to operate under chronic staffing pressure. Not only physicians but also other workforces, including pharmacists, physical therapists, and particularly nurses, are likely to be vulnerable to the market force.

Economic and Innovation Opportunities

From the perspective of the national economy, the health and wellness industry has the potential to serve as a vital new growth engine for post-pandemic Thailand. Thailand's medical tourism sector has made substantial economic contributions, generating an estimated US Dollar (US\$) 615 million from over one million patient visits as early as 2005, establishing the country as a leading Asian medical tourism destination.²⁷ More recent patient-level analyses using hospital records and tourist surveys confirm that medical tourism spending contributes meaningfully to the Thai economy, with private hospitals driving service expansion, although most patients originate from within the region rather than from distant Western markets.^{28,29} As global trade dynamics shift amid 'globalization decoupling' and geopolitical realignments, Thailand is uniquely positioned to leverage its neutrality and strategic location in Southeast Asia. This shift favors the region as a stable destination for international investment and medical tourism, particularly as affluent demographics in Asia and the Middle East seek high-quality care outside traditional Western centers.^{28,30} Furthermore, the rapid growth of the wellness sector

represents a "new galaxy" of economic activity that transcends traditional "sick-care" and taps into a lucrative global market for longevity and preventive medicine. The global wellness tourism sector was valued at US\$639.4 billion in 2017 and grew approximately 6.5% annually from 2015–2017,³¹ while the broader longevity economy, serving aging populations and chronic-care markets, has been estimated to represent multi-trillion-dollar opportunity spaces.^{32,33} The post-pandemic era has catalyzed a documented shift from reactive sick-care toward preventive, wellness, and longevity-oriented models of care.³⁴ This commercial momentum is bolstered by a rising tide of biomedical innovation; the convergence of academic research and private capital is accelerating the adoption of cutting-edge technologies, including genomic medicine and advanced therapeutics. These supportive structures collectively grant Bangkok a formidable competitive advantage, transforming it into a node of high-value industry. However, this promising trajectory is not without risk. Comparative analyses and policy frameworks demonstrate that rapid private-sector expansion in health systems can create dual-speed healthcare delivery and raise significant equity concerns, potentially undermining universal health coverage goals unless accompanied by appropriate regulatory safeguards.^{34,35} While these megaclusters offer a path to economic resilience and scientific prestige, they also risk producing a two-tiered system in which profit-driven expansion without equity protections may leave poorer populations behind. Consequently, the rise of Bangkok as a health megacluster presents a complex paradox: it is simultaneously a potential source of national economic growth and a potential threat to the egalitarian foundations of the country's healthcare delivery.

Technology Adoption and Medical Inflation

Beyond workforce redistribution, the emergence of large health megaclusters may exert upward pressure on healthcare expenditure through several interconnected mechanisms. Competition among major healthcare providers increasingly revolves around the acquisition of cutting-edge technologies, highly specialized services, and internationally recognized expertise. Investments in genomic medicine, robotic surgery, artificial intelligence, advanced therapeutics, and precision diagnostics undoubtedly improve the capability of healthcare systems and may generate substantial economic returns. However, these innovations are often associated with

high capital and operational costs, which may ultimately contribute to medical inflation if their adoption outpaces demonstrated population-level benefit.³⁶ Empirical analyses of robot-assisted surgery adoption have documented increased per-case costs and expanded procedural volumes without clear improvements in population-level outcomes.³⁷ Although Thailand has performed well as a healthcare service provider, the country is merely an end user of medical technology, meaning the success of this business largely depends on the upstream supply chain stability.

Medicalization and the Convergence of Healthcare and Wellness

An equally important but less frequently discussed phenomenon is the progressive blurring of the boundary between healthcare and wellness. Traditionally, healthcare systems were primarily designed to diagnose and treat disease. In contrast, the emerging wellness economy increasingly targets healthy individuals who seek to optimize longevity, reduce future health risks, or improve physical and cognitive performance. As preventive screening, genomic risk profiling, biological age assessment, and longevity-oriented interventions become commercialized, more aspects of everyday life may come under medical supervision. This process, often described as medicalization, expands the scope of healthcare consumption beyond illness itself.³⁸ While some interventions may provide genuine health benefits, others may generate demand without clear evidence of meaningful clinical outcomes. Consequently, the rise of Bangkok's health megacenter may accelerate a transition from a healthcare economy centered on treating disease to one increasingly focused on managing risk, uncertainty, and aging. Such a transition creates significant economic opportunities but also raises concerns regarding affordability, resource allocation, and equity. If access to advanced technologies and longevity services becomes concentrated among affluent populations, healthcare inflation may further widen disparities in health outcomes and accessibility, challenging the long-term sustainability of universal healthcare systems.

Governance and Policy Priorities

Navigating this paradox requires not resistance to Bangkok's health megacenter but deliberate governance to harness its benefits while mitigating its risks. At the policy level, stronger regulatory and financing linkages between premium centers and the Universal Coverage Scheme

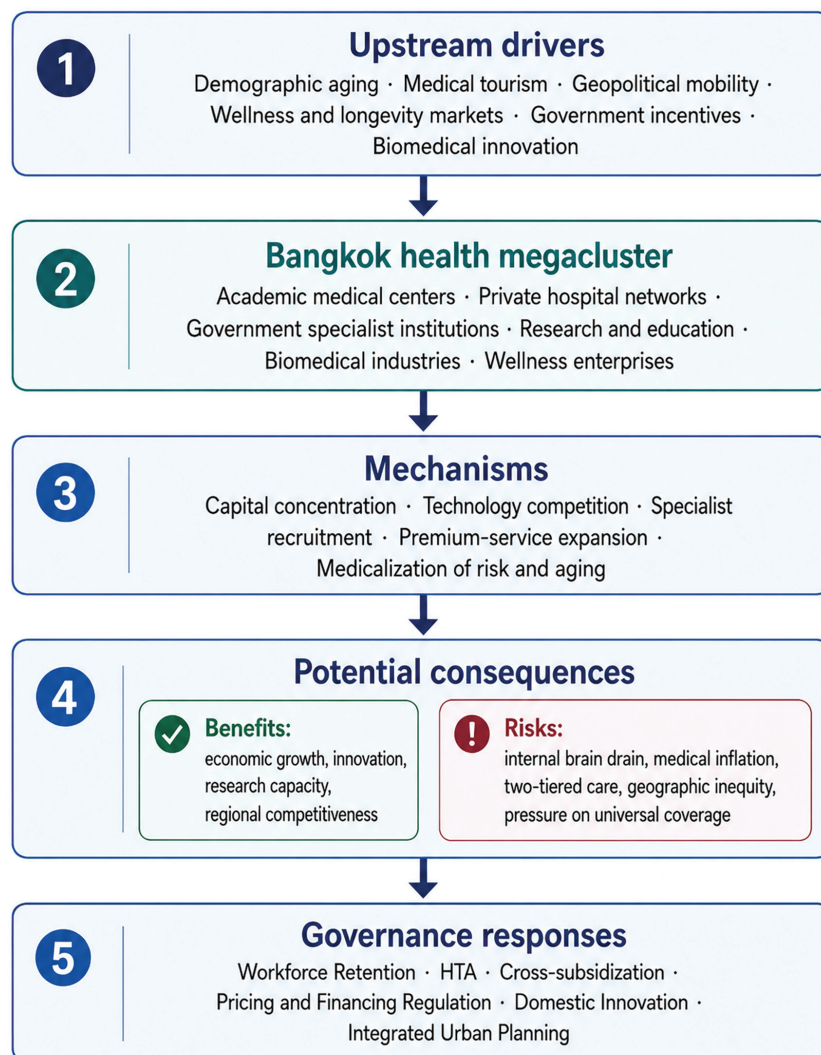
should be considered. Potential mechanisms could include negotiated contributions, public-private service agreements, or other forms of cross-subsidization, although their feasibility and distributional effects would require formal assessment in the Thai context. Evidence from targeted insurance schemes and reviews of health financing in low- and middle-income countries suggests that pooling arrangements and deliberate cross-subsidization may improve financial protection and access for underserved populations; however, their effectiveness remains context-dependent and requires robust governance.³⁹⁻⁴¹ Workforce policies must similarly anticipate and counterbalance centripetal pulls toward Bangkok by expanding targeted rural recruitment tracks, bonding schemes, and career ladders that make service outside the capital professionally and financially attractive. Global reviews of compulsory service programs in more than 70 countries, analyses of financial-incentive return-of-service designs, and WHO policy recommendations consistently emphasize that bundled strategies, including conditional scholarships, regulatory enforcement, and professional development support, are necessary to improve rural retention, though single interventions rarely suffice and long-term sustainability depends on careful program design.⁴²⁻⁴⁴ In parallel, national health technology assessment (HTA) and pricing regulations should play a more assertive role in moderating the diffusion of costly innovations, prioritizing technologies with demonstrated population-level benefit and guarding against unchecked medicalization. Comparative analyses of HTA systems across multiple jurisdictions show that HTA bodies routinely inform coverage and pricing decisions, shape market access through managed entry agreements, and apply methodological scrutiny to high-cost technologies, thereby encouraging efficient adoption and restricting low-value or premature diffusion.⁴⁵ Investment in biomedical research and innovation may reduce technological dependency and help the country enter the medical supplies manufacturing industry in the long run. Finally, urban planning and health policy need to be explicitly integrated: zoning, transportation, and housing policies around emerging medical districts can be designed to support mixed-income communities and public access, ensuring that the megacenter's physical growth does not translate into social exclusion. International commissions and cross-national practice reviews underscore that intersectoral governance linking urban design, transport, housing, and health services can reduce inequities and enhance equitable access to

care, particularly in rapidly transforming cities, although realizing these goals requires sustained cross-sectoral coordination and participatory planning approaches.^{46,47}

CONCLUSION

In conclusion, Bangkok's emergence as a health megacluster is not an aberration but a logical outcome of demographic change, geopolitical realignment, and Thailand's longstanding strengths in healthcare and hospitality. Whether this trajectory ultimately reinforces or erodes the foundations of universalism in the Thai health system will depend on choices made in the coming decade. If left solely to market forces, the megacluster may crystallize into a dual-speed system

that delivers world-class longevity services to a global elite while provincial and peri-urban populations face persistent constraints in basic care. Conversely, if policymakers, academic institutions, private investors, and city authorities align around a shared vision, treating Bangkok's health megaprojects as national infrastructure rather than isolated profit centers, Bangkok's expanding health infrastructure could become a powerful engine for both economic resilience and health equity (Figure 1). The challenge for Thailand is therefore not to halt the rise of its health megacluster but to govern it in a way that keeps the promise of universal, people-centered care at the heart of its healthcare future.



Abbreviation: HTA: health technology assessment

Figure 1 Conceptual Framework Showing the Upstream Drivers, Structural Components, Mechanisms, Consequences, and Governance Responses Associated with Bangkok's Emerging Health Megacluster

Conflict of Interest

The author declares no conflicts of interest.

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ORIGINAL ARTICLE

Impact of a Type and Screen Protocol on Surgical Blood Utilization Indices: A Retrospective Pre- and Post-Implementation Study at Vajira Hospital

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ABSTRACT

Objectives: To evaluate the impact of type and screen protocol for surgical blood management by comparing three blood utilization indices, the proportion of inadequate preoperative crossmatches, and the incidence of blood incompatibility before and after protocol implementation.

Materials and Methods: This retrospective pre- and post-protocol study analyzed anesthetic records and blood reservation data of adult inpatients in 11 departments who underwent elective surgeries at Vajira Hospital between November 2020 and April 2021 (pre-protocol group) and between August 2021 and January 2022 (post-protocol group). Three blood utilization indices, namely, crossmatch-to-transfusion (C/T) ratio, transfusion probability (%T), and transfusion index (Ti), were calculated for each department and overall, then compared to international benchmarks. Multilevel mean difference regression was utilized to investigate the protocol's impact on three indices, as well as on the percentage of inadequate preoperative crossmatch and transfusion mismatches.

Results: The study included 1533 patients in the pre-protocol group and 1404 patients in the post-protocol group. Multivariable analysis adjusted for patient demographics, preoperative laboratory results, and intraoperative blood loss demonstrated significant improvements in the C/T ratio (mean difference (MD) -0.65, $p < 0.01$), %T (MD 34.1%, $p < 0.01$), and Ti (MD 0.5, $p < 0.01$) following protocol implementation. However, C/T ratios across all departments still failed to meet international benchmark. The proportion of inadequate preoperative crossmatches did not differ significantly between the two periods (MD -0.73, $p = 0.15$) and no blood incompatibilities were recorded in either group.

Conclusion: The type and screen protocol were associated with improved blood utilization efficiency for elective surgeries at Vajira Hospital without difference in percentages of underordering. While these observational findings are promising, C/T ratios failed to reach international standard. Further refinement of the protocol or the development of an institute-specific maximum surgical blood-order schedule is recommended.

Keywords: blood utilization, crossmatch-to-transfusion ratio, type and screen

INTRODUCTION

Blood utilization is the appropriate and effective use of blood products to maintain a safe and adequate blood supply. This has long been a focus for many organizations involved in transfusion therapy.¹ However, several countries still faced inadequate supplies of red cell products.² Previous studies have shown that elective surgeries often involved over-ordering of blood components that were not ultimately transfused.³⁻⁸

In the traditional crossmatch method, compatible units of red cell products are removed from general inventory, reserved for immediate use by matched recipients, and decreased availability for other patients for at least 48 hours. The type and screen (T&S) method has been proposed as a substitute compatibility test for procedures wherein transfusion was less likely.⁹⁻¹¹

This approach involved testing a recipient's blood for ABO and Rhesus types and irregular antibodies without involving donor units. Research revealed that T&S increased the availability of blood in stock, reduced the number of expired units, lowered costs associated with unnecessary complete crossmatches, and decreased blood bank staff workload.¹²⁻¹⁵ Moreover, T&S for blood reservation maintained patient safety with concerning timely blood release and compatibility.^{10,13,16}

The T&S method was integrated into Maximum Surgical Blood Order Schedule (MSBOS), a clinical framework designed to optimize preoperative blood reservation. The MSBOS facilitates the decision of whether a T&S is appropriate for a specific procedure and establishes the maximum number of packed red blood cells (PRCs) to be ordered if crossmatching is warranted, based on the anticipated risk of major hemorrhage and documented transfusion requirements.^{11,17}

During the Coronavirus Disease 2019 (COVID-19) pandemic, blood donations decreased worldwide.¹⁸⁻²⁰ In Thailand, this problem led to blood supply shortage.²¹ To deal with this issue, Vajira Hospital implemented the T&S protocol for elective surgical blood management to ensure sufficient blood reserves. Prior to the implementation of the protocol, no explicit guidelines for preoperative blood ordering existed. The number of PRCs crossmatched for surgery was determined at the discretion of the attending surgeons or residents. Following protocol initiation, PRCs ordered by surgical teams as "crossmatch for operation" were prepared using T&S in a blood bank. On surgery day, during the sign-in process, anesthesiologists determined whether to request a crossmatch for each patient and

the number of PRC units required, considering the type of surgery and patient profiles. Then, the blood bank delivered the typed and screened PRCs, as requested, to the operating rooms within 15 minutes, while performing a complete crossmatch in parallel. However, T&S did not cover all situations; a complete crossmatch was permitted from the outset for patients with rare blood types and antibodies against red blood cells, those scheduled for cardiac or transplant surgeries, those aged < 10 years, and those receiving blood components donated by relatives.

The T&S protocol has been used for elective surgical patients at Vajira Hospital since May 2021; thus, its result in improving blood utilization and its consequence on patient safety have not been formally evaluated. Therefore, the primary objective of this study was to evaluate the impact of the protocol by comparing three key blood utilization indices, namely, crossmatch-to-transfusion (C/T) ratio,¹² transfusion probability (%T),²² and transfusion index (Ti),¹¹ during the 6-month periods before and after implementation. The authors hypothesized that all indices would demonstrate significant improvement after the protocol was implemented. Additionally, the study compared the proportion of inadequate preoperative crossmatches and blood incompatibility between the two periods.

MATERIALS AND METHODS

This retrospective pre- and post-protocol study received expedited review and approval from the Vajira Institutional Review Board's Ethics Committee on 28 April 2023 (COA 081/2566). Data from patients undergoing surgery in the operating theaters at Vajira Hospital were reviewed for the 6 months before (November 2020 to April 2021) and after (August 2021 to January 2022) T&S implementation. The initial 3 months of the transition period were excluded to ensure consistent practices among all personnel. The inclusion criteria involved patients aged > 15 years who were admitted for non-emergency surgeries in one of the following 11 departments: orthopedic surgery, general surgery, esophagogastric surgery, colorectal surgery, hepatobiliary surgery, urologic surgery, vascular surgery, neurosurgery, plastic surgery, thoracic surgery, and otolaryngology surgery. The exclusion criteria comprised patients with international normalized ratio > 1.5, activated partial thromboplastin time (aPTT) > 40 seconds, or thrombocytopenia (platelet count < 80,000 cells/mm³); those on

antiplatelet or anticoagulant therapy without appropriate cessation (except for vascular surgery); those undergoing procedures with preexisting blood management guidelines (e.g., cesarean section, organ transplantation, and cardiac surgery); those undergoing procedures for which preoperative blood management was not routinely required (e.g., eye surgery, ear surgery, rigid bronchoscopy, direct laryngoscopy, vocal cord surgery, hemorrhoidectomy, and fistulectomy); those simultaneously undergoing multiple unrelated surgical procedures; and those whose planned operations were changed intraoperatively.

Data were extracted from anesthesia records and the blood bank's electronic database. This included patient age, sex, weight, height, comorbidities such as end-stage renal disease (ESRD) and cirrhosis, American Society of Anesthesiologists Physical Status (ASA-PS) classification, preoperative laboratory results (e.g., hematocrit, platelet count, and coagulation profiles), department, operation performed, intraoperative blood loss, type and amount of preoperative and intraoperative PRC orders, the number of PRC units transfused intraoperatively, and intraoperative record of suspected blood incompatibility. Inadequate preoperative crossmatching was identified when the quantity of transfused PRCs exceeded the preoperatively crossmatched volume.

Data were analyzed using Stata version 14.4 (StataCorp LLC., College Station, T.X., USA) and Microsoft Excel version 16.0 (Microsoft Corp., Redmond, W.A., USA). To evaluate blood product utilization, three indices were calculated for each department and overall patients. The C/T ratio was determined by dividing the total number of units of blood crossmatched by the total number of units of blood transfused. A C/T ratio ≤ 2 indicated appropriate blood use.¹² The %T was calculated by dividing the number of patients transfused by the number of patients crossmatched and multiplying the result by 100. The %T should be at least 30% to ensure that proper proportion of patients who had been cross-matched were precisely transfused.²² Finally, the Ti was obtained by dividing the number of units of blood transfused by the number of patients crossmatched. A Ti of at least 0.5 indicated that blood products were efficiently used.¹¹

Because the three transfusion indices were calculated as aggregated metrics, the department served as the unit of analysis. Data normality was

evaluated using the Shapiro-Wilk test. Patient demographics in each department were presented as means and standard deviations or medians and interquartile ranges (IQR), depending on the data distribution. For comparisons between the pre- and post-protocol periods at the department level, the dependent-samples t-test or the Wilcoxon signed-rank test was employed, as appropriate. To evaluate the impact of the T&S protocol while accounting for the hierarchical structure of the data, a multilevel mean difference regression model with a random intercept and fixed effects was utilized. This model analyzed changes in the C/T ratio, %T, Ti, and the percentage of inadequate preoperative crossmatches and blood incompatibility. Results were reported as mean differences with 95% confidence intervals. Statistical significance was defined as $p < 0.05$.

RESULTS

Overall, 2937 patients undergoing 258 different surgical procedures were analyzed. Of these, 1533 were in the pre-protocol group and 1404 in the post-protocol group. The distribution of patients across departments is summarized in **Table 1**. The department of orthopedic surgery had the largest patient volume, while the esophagogastric surgery department had the smallest. **Table 2** presents patients' demographics, preoperative laboratory values, and intraoperative blood loss. Statistically significant differences between the two groups were observed in age, preoperative hematocrit, platelet count, and aPTT.

In the pre-protocol period, none of the blood utilization indices for overall patients met the benchmarks for appropriate use: C/T ratio, 5.87 (**Figure 1**); %T, 18.3% (**Figure 2**); and Ti, 0.38 (**Figure 3**). In examining each department, C/T ratios exceeded 2 and %T was $< 30\%$ in all 11 departments. Esophagogastric surgery had the highest C/T ratio (9.25), whereas Ear, Nose, and Throat surgeries exhibited the lowest %T (10.6%). Regarding Ti, only colorectal, hepatobiliary, and neurosurgery achieved the target value > 0.5 , with neurosurgery reaching the highest Ti (0.62).

In the post-protocol period, the blood utilization indices for overall patients improved: C/T ratio, 3.79 (**Figure 1**); %T, 39.2% (**Figure 2**); and Ti, 0.73 (**Figure 3**). However, the C/T ratio remained above the target value in all departments. Except urology and plastic surgery, all departments achieved the appropriate %T and Ti values. Neurosurgery achieved the highest %T and Ti during the post-protocol period.

Table 1 Distribution of Surgical Patients by Department between Pre- and Post-Type and Screen Protocol Implementation Periods

Departments	Pre-protocol n (%)	Post-protocol n (%)
General surgery	144 (9.4)	109 (7.8)
Esophagogastric surgery	19 (1.2)	7 (0.5)
Colorectal surgery	73 (4.8)	77 (5.5)
Hepatobiliary surgery	90 (5.9)	98 (7.0)
Vascular surgery	68 (4.4)	88 (6.3)
Neurosurgery	154 (10.0)	131 (9.3)
Otolaryngology surgery	114 (7.4)	126 (9.0)
Thoracic surgery	97 (6.3)	96 (6.8)
Plastic surgery	46 (3.0)	48 (3.4)
Urologic surgery	137 (8.9)	119 (8.5)
Orthopedics surgery	591 (38.6)	505 (36.0)
Overall patients	1533 (100.0)	1404 (100.0)

Abbreviation: n, number

Table 2 Comparison of Patients' Demographics, Preoperative Laboratory, and Intraoperative Blood Loss between Pre- and Post-Type and Screen Protocol Implementation

Variables	Pre-protocol (n = 11)	Post-protocol (n = 11)	P-value
Percentage of male	47.8 [40.4-63.0]	42.9 [37.5-59.7]	0.37
Age (years)	55.5 ± 4.9	57.8 ± 3.5	0.04*
Weight (kg)	65.3 [62.6-66.2]	63.4 [61.0-64.3]	0.29
Height (cm)	163 [161-164]	161 [161-162]	0.42
BMI (kg/m ²)	24.8 [23.5-25.1]	24.3 [23.5-25.0]	0.08
Percentage of ASA-PS classification			
I	10.0 ± 7.8	8.0 ± 5.5	0.11
II	52.8 [46.5-55.8]	49.4 [46.6-57.1]	0.72
III	36.0 [30.9-38.3]	36.7 [28.6-48.1]	0.42
IV	0.2 [0.0-1.8]	1.3 [0.9-2.3]	0.29
Percentage of comorbidity			
Cirrhosis	0.68 [0.00-1.39]	0.00 [0.00-0.79]	0.05
ESRD	0.73 [0.00-2.78]	1.39 [0.00-2.52]	0.07

Table 2 Comparison of Patients' Demographics, Preoperative Laboratory, and Intraoperative Blood Loss between Pre- and Post-Type and Screen Protocol Implementation (cont.)

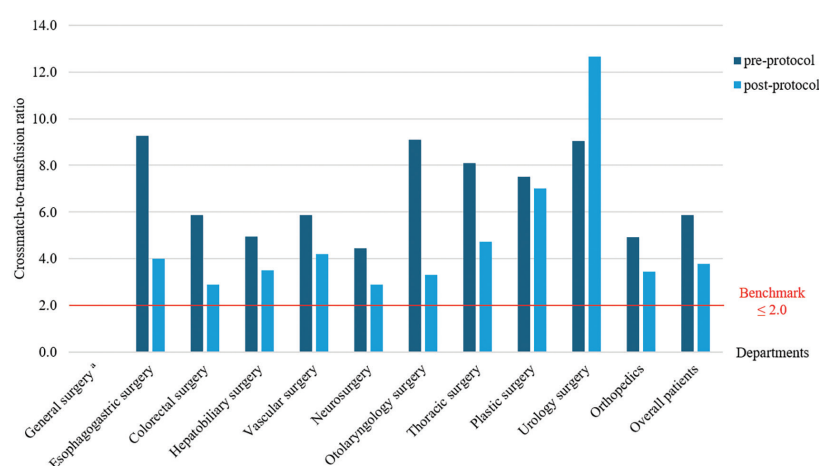
Variables	Pre-protocol (n = 11)	Post-protocol (n = 11)	P-value
Preoperative laboratory			
Hematocrit (%)	38.8 [37.7-39.3]	37.9 [36.8-38.7]	< 0.01**
Platelet (/μL)	286,000 ± 19,000	273,000 ± 17,000	0.03*
INR	1.03 [1.02-1.04]	1.03 [1.02-1.05]	0.21
aPTT (sec)	25.9 [25.7-26.4]	25.4 [25.0-25.4]	< 0.01**
Intraoperative blood loss (ml)	50 [20-100]	50 [20-150]	0.59

Abbreviations: μL, microliter; aPTT, activated partial thromboplastin time; ASA-PS, American Society of Anesthesiologists Physical Status; BMI, body mass index; cm, centimetre; ESRD, end stage renal disease; INR, international normalized ratio; kg, kilogram; m², square meter; ml, milliliter; n, number; sec, second

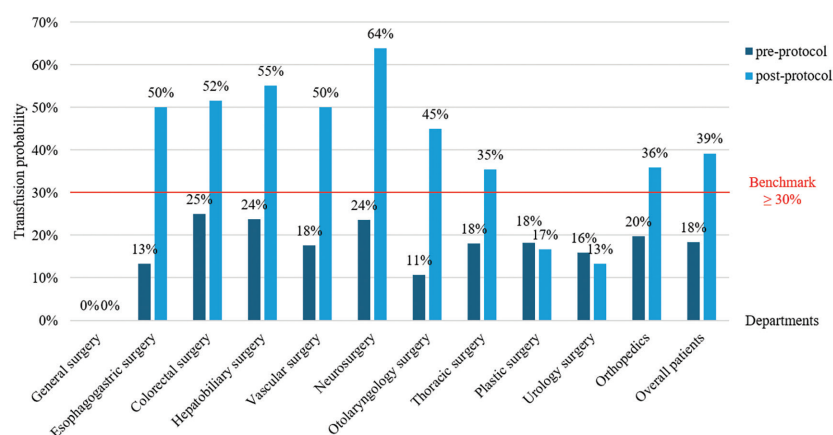
Data were presented in mean ± SD or median [IQR] according to the normality of data tested by Shapiro-Wilk test.

* p < 0.05

** p < 0.01



^aCrossmatch-to-Transfusion Ratio was Unavailable in General Surgery Department because of Absence of Blood Transfusion.

Figure 1 Comparison of Crossmatch-to-Transfusion Ratio between Pre- and Post-Type and Screen Protocol Implementation**Figure 2** Comparison of Transfusion Probability between Pre- and Post-Type and Screen Protocol Implementation

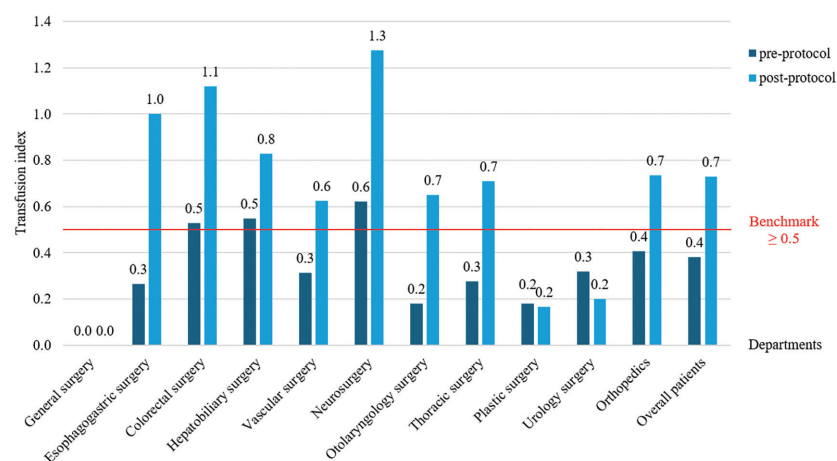


Figure 3 Comparison of Transfusion Index between Pre- and Post-Type and Screen Protocol Implementation

Interestingly, urologic surgery was the only department wherein all blood utilization indices failed to improve after T&S implementation.

In general surgery, which mainly involved breast and hernia operations, no patients received blood transfusions before or after T&S implementation, precluding calculation and comparison of the three indices. **Figure 1** compares the blood utilization indices for each department and overall patients in the pre- and post-protocol groups.

Because no PRCs were transfused in the general surgery department during either period, the C/T ratio was mathematically undefined (denominator of zero); consequently, this department was excluded from the regression analysis for the C/T ratio endpoint. Univariable

analysis demonstrated a significant decrease in the C/T ratio (mean difference (MD) -2.04, $p = 0.01$), an increase in %T (MD 21.0%, $p < 0.01$), and increase in Ti (MD 0.33, $p < 0.01$) following the protocol implementation. To account for imbalanced demographics and potential confounders, multivariate analysis was performed. Variables exhibiting high collinearity (correlation coefficient ≥ 0.7), including weight, height, ASA-PS, ESRD status, and international normalized ratio, were removed to prevent multicollinearity. After adjusting for sex, age, body mass index, cirrhosis, hematocrit, platelet count, aPTT, and median blood loss, the improvement in the C/T ratio (MD -0.65, $p < 0.01$), %T (MD 34.1%, $p < 0.01$), and Ti (MD 0.5, $p < 0.01$) remained statistically significant (**Table 3**).

Table 3 Multilevel Mean Difference Analysis of the Impact of Type and Screen Protocol on Blood Utilization Indices and Inadequate Crossmatching

Endpoints	Pre-protocol mean (SD)	Post-protocol Mean (SD)	Univariable analysis		Multivariable analysis ^a	
			MD (95% CI)	P-value	Adjusted MD (95% CI)	P-value
C/T ratio ^b	6.90 (1.90)	4.86 (3.00)	-2.04 (-3.59 to -0.49)	0.01	-0.65 (-0.93 to -0.36)	< 0.01
Transfusion probability	16.9 (7.1)	37.9 (20.0)	21.0 (11.9 to 30.1)	< 0.01	34.1 (17.2 to 51.0)	< 0.01
Transfusion index	0.33 (0.18)	0.66 (0.40)	0.33 (0.17 to 0.49)	< 0.01	0.50 (0.34 to 0.67)	< 0.01
Percentage of inadequate preoperative crossmatch	0.68 (1.13)	0.38 (0.80)	-0.31 (-0.91 to 0.30)	0.32	-0.73 (-1.73 to 0.27)	0.15

Abbreviations: CI, confidence interval; MD, mean difference; SD, standard deviation

^a Multivariable analysis adjusted for sex, age, body mass index, cirrhosis, hematocrit, platelet, activated partial thromboplastin time, and median blood loss.

^b General surgery was excluded from the analysis due to unavailability of C/T ratio from absence of blood transfusion. The remaining sample size was 10 for this endpoints.

* Statistical significance at $p < 0.05$ **

Statistical significance at $p < 0.01$

Regarding secondary outcomes, the percentage of inadequate preoperative crossmatches did not differ significantly between the two periods in either the univariable (MD -0.31, $p = 0.32$) or multivariable (MD -0.73, $p = 0.15$) analyses. Notably, no blood incompatibility events occurred intraoperatively during both study periods.

DISCUSSION

This study evaluated the impact of T&S protocol for managing surgical blood reservations at Vajira Hospital during the COVID-19 pandemic. By comparing three blood utilization indices (i.e., C/T ratio, %T, and Ti), we observed significant improvements across all metrics following protocol implementation. Although patient demographics and volumes differed between the two study periods, these imbalances likely reflect actions taken to address decreased blood supply during the COVID-19 pandemic, such as cancelling some major and elective surgeries.¹⁸ Importantly, the improvements in blood utilization remained statistically significant even after adjusting for confounders, including patient demographics, preoperative laboratory values, and intraoperative blood loss, underscoring the efficiency of the T&S protocol.

The results of this study aligned with that in Mahattanobon and Sunpaweravong's study⁴ investigating the efficiency of blood ordering guideline for elective surgery at their institution, replacing crossmatching with T&S for selected operations. They reported a decrease in C/T ratio (3.6 to 2.6), an increase in %T (36.8% to 52.3%), and an increase in Ti (0.8 to 1.1) after implementing the guidelines.⁴ Alavi-Moghaddam et al. established the benefit of T&S in the emergency department, noting a decrease in C/T ratio from 1.41 to 1.13.¹⁶ In another study, Aggarwal et al. found a notable C/T ratio decrease (1.94 to 1.01) after introducing T&S in their tertiary care hospital.¹⁵

In this study, although the overall C/T ratio improved after T&S implementation, decreasing from 5.87 to 3.79, it remained substantially higher than the target value of ≤ 2 . Moreover, the C/T ratio of the urology department increased from 9.03 to 12.67 during the post-protocol period. These unfavorable outcomes were also reported in other studies which applied T&S into the MSBOS for elective surgeries.^{4,23,24} Woodrum et al. revealed a C/T ratio of 3.17 after implementing a blood ordering schedule among many hospitals in their regional healthcare network and

mentioned inadequate program communication and noncompliance as possible causes.²³ Jitmun and Chatmongkolchart identified similar problems in Thailand.²⁴ Although the MSBOS had been established in their institution since 2008, a recent study collecting data in 2020 and 2021 revealed an overall C/T ratio of 2.78, exceeding the international benchmark. They posited that blood ordering protocols may be ignored and blood utilization may remain inefficient without consistent follow-up and feedback.²⁴

For Vajira Hospital, a potential reason for unfavorable C/T ratios after T&S implementation is that the protocol itself was not rigorous in controlling the number of PRCs reserved for each operation, causing over-ordering of PRCs by junior residents with limited experience for certain operations and inaccurate predictions of blood loss. Furthermore, the protocol had weaknesses allowing deviation from the prescribed requirements, that is, to switch from T&S back to complete crossmatching. First, the protocol specified that PRCs should be prepared using T&S only if they were ordered in the Hospital Management Information System (E-Phis) as "crossmatch for operation." Thus, if orders were placed as "ready to use," the PRCs would be completely crossmatched. Second, every unit of PRC reserved for patients whose relatives donated blood would be crossmatched. The campaign to encourage patient relatives to donate blood intensified after the COVID-19 pandemic, along with T&S initiation. Some PRCs originally ordered as T&S during the pre-protocol period may have been crossmatched during the post-protocol period for this reason, increasing the C/T ratio. Finally, any PRCs launched to operating rooms would be automatically crossmatched, regardless of the requestors, such as anesthesiologists, nurse anesthetists, surgical staffs, and trainees. This allowed less-experienced practitioners to request excessive PRCs to the operating room.

Moreover, the present study found improvements in overall %T and Ti, increasing from 18.3% to 39.2% and 0.38 to 0.62, respectively. These indices reached target values in all departments except urology and plastic surgery. The discrepancy among departments, especially in urology, wherein all blood utilization indices worsened during the post-protocol period compared to pre-protocol, requires further investigation for hidden causes. Apart from ensuring understanding of the protocol and compliance of the personnel within the department, the details of operation may

provide an explanation on surprising outcomes in urology. Less-invasive procedures implemented to alleviate blood shortage during the COVID-19 pandemic may have decreased actual blood transfusions than the requested units, increasing the C/T ratio. Furthermore, other studies demonstrated higher C/T ratios in urologic procedures compared to other subspecialties, ranging from > 3.00 to 5.88 .^{17,24,25} Uniqueness of operations and organ involved, bleeding complications, and the increasing use of less-invasive surgical techniques in the urological field may contribute to the imbalance between the numbers of units ordered and transfused.

Another notable finding concerned the general surgery department, which involved breast surgeries and hernia repairs. Although no transfusions were required during the study periods, crossmatches were occasionally requested in some patients, with a smaller proportion after the T&S protocol implementation (50.0% vs. 20.2%). Other studies reported that blood reservations could be omitted^{17,25} or that T&S was sufficient for these operations.⁴

Given the risks associated with T&S, this study found similar percentages of patients with inadequate crossmatch between pre- and post-protocol periods. This paralleled findings from another university hospital in Thailand, which reported nonsignificantly different proportion of patients transfused with more blood than preoperatively crossmatched (2.5% vs 2.3%) after introducing a blood ordering schedule.⁴ In the current study, no intraoperative blood incompatibility was found, supporting the safety of T&S reported in the existing literature.^{10,13,16}

Despite improvements in blood utilization at Vajira Hospital after T&S implementation, opportunities remain for further gains. During the post-protocol period, only 26.4% (264 units) of crossmatched PRCs were transfused intraoperatively. Considering that the C/T ratio was the only index below the international standard, the authors hypothesized that excessive preoperative crossmatching per patient was the primary driver of inefficient blood use. This necessitated the development of an institute-specific MSBOS to provide a structured guideline, defining the appropriateness of T&S and setting a ceiling for the number of PRC units for surgical blood reservation. Numerous studies demonstrated the benefits of MSBOS in blood utilization, patient safety, and cost savings.^{7,25-28} Although various calculation strategies for establishing MSBOS have

been proposed,^{17,22,29,30} the researchers used a method by Frank et al.¹⁷ to recommend MSBOS for Vajira Hospital.

A major strength of this study is the large patient cohort and the use of inferential statistics. While previous studies have often reported the effect of T&S method in a purely descriptive manner, comparing results to international benchmark, this study employed multilevel mean difference regression. This approach allowed us to confirm the protocol's impact and explore the effect size on improving surgical blood utilization.

However, this study still had several limitations. First, the retrospective design limited comprehensive assessment of complications resulting from the protocol, such as delayed transfusions and subsequent morbidity. The reasons for switching from T&S to crossmatching were not recorded in the blood bank database, limiting the evaluation of protocol compliance and deviations that may have decreased the protocol's effect. Second, residual potential confounders, such as variations in surgeon expertise, disease severity, and the specific types of operations performed, may have influenced the results. The COVID-19 pandemic caused blood shortages that delayed some elective major surgeries, resulting in less PRCs reservation for operation and thus improvement of blood utilization indices during the post-protocol period. However, this study did not analyze outcomes at the individual procedure level, as the mathematical invalidity of the C/T ratio (where the denominator is zero) and the lack of matched operations in both time periods would have led to significant data exclusion. Consequently, the result would not demonstrate the impact of the T&S protocol on entire patient cohort. Third, the study only considered intraoperative transfusions in the calculations, not recognizing the potential influence of blood use during the postoperative period. Finally, a single-center design limited the external validity of these findings. Future research should prioritize prospective designs to get rid of potential confounders and explore the protocol's impact on procedure level. Moreover, impact of the suggested MSBOS should be evaluated.

CONCLUSION

T&S protocol implementation significantly improved all three indices of blood utilization for elective surgeries. However, in all departments, the C/T ratio remained failed to reach international benchmark. Revision of

the protocol or developing an institute-specific MSBOS is recommended. No blood incompatibility was recorded, and proportion of inadequate preoperative crossmatch did not significantly differ following protocol implementation.

Conflict of Interest

The authors declare no conflicts of interest.

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Author Contributions

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Formal analysis: S.H., P.P.

Funding acquisition: P.P.

Investigation: S.H., S.T., P.S., A.C., S.K., M.P.

Methodology: S.H., P.P.

Project administration: P.P.

Resources: P.P.

Software: -

Supervision: P.P.

Validation: -

Visualization: P.P.

Writing – original draft preparation: S.H.

Writing – review & editing: P.P.

Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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ORIGINAL ARTICLE

Association between Fasting Blood Sugar Levels and Psoriasis Severity using the PASI Score: A Single-Center Cross-Sectional Study

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ABSTRACT

Objectives: Psoriasis is a chronic immune-mediated inflammatory skin disease characterized by dry, thick, raised patches. The Psoriasis Area and Severity Index (PASI) measures disease severity body surface area and treatment efficacy. Psoriasis can increase the risk of diabetes and worsen insulin resistance, resulting in increased fasting blood sugar (FBS) and worsening diabetic symptoms. This study aimed to study the correlation between FBS and PASI score in psoriasis patients.

Materials and Methods: This retrospective study analyzed the relationship between PASI scores and FBS levels in psoriasis patients who visited the Dermatology Outpatient Clinic between 2019 and 2023. PASI scores were assessed by dermatologists, and FBS levels collected within a month of PASI evaluation were analyzed. Patients were categorized into diabetes mellitus (DM) and non- diabetes mellitus (non-DM) groups. Those on systemic therapy or without FBS were excluded.

Results: Data from 65 psoriasis patients were analyzed (non-DM (n = 58), DM (n = 7)). The average PASI score was 8.4 (5.9, 10.9) in non-DM patients and 7 (2.7, 4) in DM patients, respectively. Mean FBS levels were evaluated based on PASI severity: mild (n = 36) - 109.4 (100.1, 118.8), moderate (n = 13) - 103.6 (95.9, 111.4), and severe (n = 16) - 96.8 (92.9, 100.6). Comparison of mean FBS across PASI severity categories showed no statistically significant differences (mild vs. moderate: mean difference 5.7 milligrams (mg)/ deciliter (dL), p = 0.416, 95% confidence interval (CI) -8.3 to 19.8; moderate vs. severe: mean difference 6.8 mg/dL, p = 0.402, 95% CI -9.4 to 23.1; mild vs. severe: mean difference 12.6 mg/dL, p = 0.058, 95% CI -0.4 to 25.7).

Conclusion: No significant correlation was found between FBS levels and PASI scores in either the DM or non-DM groups.

Keywords: fasting plasma sugar level, psoriasis area and severity index, psoriasis

INTRODUCTION

Psoriasis is a chronic inflammatory systemic condition that is challenging to cure but controllable. The infiltration of activated T cells into the skin, which stimulates the proliferation of keratinocytes, plays a critical role in its pathogenesis.¹ In particular, pro-inflammatory cytokines such as interleukin-17 and tumor necrosis factor alpha have been linked to systemic inflammation that can impair insulin signaling and glucose metabolism.² Psoriasis symptoms vary from person to person, but it typically presents as well-defined erythematous plaques with white-silvery scales. These plaques commonly appear on the elbows, knees, scalp, and lumbosacral areas, forming a recognizable pattern.³ Psoriasis affects approximately 2-3% of the world's population, or approximately 125 million individuals. In Thailand, psoriasis prevalence is 2% of the population.⁴ Psoriasis is associated with several complications, including metabolic syndrome and increased risk of cardiovascular disease.⁵⁻⁷ Diabetes is one of the most prevalent metabolic disorders in Thailand, affecting 9.7% of the population.⁸ Psoriasis has been linked to an increased risk of developing diabetes and poorer insulin resistance, leading to elevated fasting blood sugar (FBS) levels and exacerbated diabetic symptoms.^{5,9}

Several previous studies have evaluated the relationship between psoriasis severity and metabolic parameters in both diabetic and non-diabetic populations. While population-based studies consistently demonstrate an increased risk of diabetes among patients with psoriasis, evidence regarding the direct association between the Psoriasis Area and Severity Index (PASI) score and glycemic indices remains inconsistent. Some investigations have reported increased insulin resistance in psoriasis patients regardless of PASI severity, whereas others found no significant correlation between disease severity and fasting glucose after adjustment for confounding factors such as age, obesity, and systemic treatment.^{2,10,11} These inconsistencies highlight the need to further examine the relationship between FBS levels and psoriasis severity in both diabetes mellitus (DM) and non-diabetes mellitus (non-DM) groups. Given this association, the researchers aim to examine the correlation between FBS levels and psoriasis severity using the PASI score, the gold standard assessment tool.^{12,13}

MATERIALS AND METHODS

This study is a retrospective analysis of psoriasis patients at Siriraj Hospital. The primary objective is to analyze the association of FBS levels and PASI scores. As a retrospective study, anonymized data

was used, and patient consent waived. The study was approved by the Siriraj Institutional Review Board (COA no. Si 227/2024).

Patients included in the study were those diagnosed with psoriasis at Siriraj Hospital between 2019 and 2023, aged 18 or older, with available diabetic laboratory data including complete blood count, liver and kidney function tests, and diabetic laboratory assessments. The exclusion criteria were prior treatment with phototherapy for more than one month before the index date or had incomplete laboratory data. Patients were categorized into DM and non-DM groups based on documented medical diagnosis and/or a diagnostic threshold of FBS > 126 milligrams (mg)/deciliter (dL). Given the retrospective design, DM classification was based on available FBS measurements within one month before and after the index date. Hemoglobin A1c (HbA1c) values, when available, were reported descriptively but were not used as the primary classification criterion due to incomplete data across participants. Psoriasis severity was categorized according to PASI score as mild (< 10), moderate (10–15), and severe (> 15).¹³⁻¹⁶

This study aims to predict PASI scores using FBS levels. Based on a 2015 study on DM in psoriasis patients, the prevalence of DM was reported as 4.7% ($n = 2017$, $p = 0.0476$, confidence interval (CI) = 95%).¹⁷ Using Cochran's sample size formula, a minimum of 70 individuals were needed to provide adequate statistical power. To account for an expected 30% exclusion rate, we adjusted the sample size using the following formula: $N_{\text{adjusted}} = N_{\text{required}} / (1 - \text{exclusion rate}) = 70 / (1 - 0.30) \approx 100$. Consequently, we initially recruited 100 participants to ensure enough number of analyzable cases.

Relevant variables were extracted from electronic records for each patient and compiled into a datasheet. The recorded values included enrollment date, sex, date of birth, current age, DM status (yes or no), FBS one month before and after the index date, HbA1c, current PASI score, age of psoriasis onset (years), type of psoriasis, presence of psoriatic arthritis (yes or no), presence of plaque (yes or no), history of phototherapy (yes or no), history of systemic treatment (yes or no), and presence of other skin diseases (yes or no).

Data analysis was performed using SPSS software version 26.0. Categorical variables, including sex, treatment history, psoriasis severity, and psoriasis type were analyzed and reported as frequencies. Continuous variables, such as age, comorbidities, laboratory investigations, and disease severity were analyzed using means, interquartile ranges, and standard

deviations. Descriptive statistics were used to compare mean FBS levels across PASI severity subdivisions (mild, moderate, severe) and mean PASI scores between DM and non-DM groups. Mean FBS levels were compared across PASI severity subdivisions (mild, moderate, severe) using one-way analysis of variance with Least Significant Difference (LSD) post hoc multiple comparisons. Mean PASI scores were descriptively compared between DM and non-DM groups. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 65 subjects were included in the final analysis. Of the 100 initially recruited participants, 35 were excluded due to incomplete laboratory data or meeting exclusion criteria. The characteristics of the study population are described in **Table 1**. Patients were categorized by PASI severity as mild (< 10), moderate (10–15), and severe (> 15).^{14,15} Mean FBS levels were compared across these three PASI severity categories, and pairwise comparisons were performed (mild vs moderate, mild vs severe, and moderate vs severe) using the LSD post hoc procedure (**Table 2**). For descriptive presentation, moderate and severe psoriasis were combined due to small subgroup sizes.

Initially, 16 patients were diagnosed with DM. After assessing their FBS levels 1 month before and after the index date using the cut-off, only seven patients met the criteria for DM. The comparison between each PASI severity (**Table 2**), among mild and moderate PASI severity showed no statistically significant difference (mean difference = 5.7, $p = 0.416$, 95% CI: -8.3 to 19.8). Similarly, the difference between moderate and severe PASI severity was also not statistically significant (mean difference = 6.8, $p = 0.402$, 95% CI: -9.4 to 23.1). A larger difference was observed between mild and severe PASI severity (mean difference = 12.6, $p = 0.058$, 95% CI: -0.4 to 25.7), but this difference did not reach statistical significance. These results suggest that there were no significant differences in FBS levels among PASI severity groups, despite a trend suggesting higher FBS levels in the severe PASI group compared to the mild PASI group.

Across PASI severity subdivisions, differences in mean FBS levels were observed within a one-month period. The highest mean FBS was recorded in the mild PASI severity group (109.4 ± 27.6 mg/dL), followed by the moderate PASI severity group (103.6 ± 12.8 mg/dL). The severe PASI group had the lowest mean FBS level (96.8 ± 7.2 mg/dL). Overall, the mean FBS for all subjects was 105.2 ± 22.1 mg/dL. These findings are consistent with results presented in **Table 3**.

Table 1 Demographic Data of Psoriasis Patients with Varying FBS Levels within a 1-Month Period of PASI Score Evaluation (n = 65)

Demographic Data	n (%)
Sex	
Male	39 (60)
Female	26 (40)
Mean age $\pm$ SD, years	49.3 $\pm$ 14.6
Comorbidities	
Hypertension	19 (29.2)
Dyslipidemia	18 (27.7)
DM	16 (24.6)
Severity of Psoriasis	
Mild	49 (75.4)
Moderate to severe	16 (24.6)
Types of psoriasis	
Plaque type	58 (89.2)
Guttate type	3 (4.6)
Erythroderma type	2 (3.1)
Pustular type	2 (3.1)
Psoriatic arthritis involvement	15 (23.1)
Investigations	
FBS, mg/dL (IQR)	105.2 (92.0, 112.5)
HbA1c, mg%(IQR) (n = 36)	6.2 (5.6, 6.4)
Disease severity	
BSA, % (IQR)	4.4 (2.7, 10.3)
PASI score (IQR)	7.0 (4.0, 15.0)
Treatment*	
Topical steroid	63 (96.9)
Systemic medication (Oral methotrexate)	41 (63.1)
Systemic medication (cyclosporine)	11 (16.9)
Systemic medication (acitretin)	18 (27.7)
Phototherapy	17 (26.2)

Abbreviations: BSA, body surface area; dL, deciliter; DM, diabetes mellitus; FBS, fasting blood sugar; HbA1c, hemoglobin A1c; IQR, interquartile range; mg, milligrams; PASI, psoriasis area and severity index; SD, standard deviation

* Some patients were prescribed more than one type of treatment.

Table 2 Multiple Comparisons using Least Significant Difference between PASI Severity and Mean FBS Levels in Subjects

(I) PASI Severity	(J) PASI Severity	Mean Difference (I-J)	Std. Error	Sig.	95 % Confidence Interval	
					Lower Bound	Upper Bound
Mild	Moderate	5.7	7.0	.416	-8.3	19.8
	Severe	12.6	6.5	.058	-0.4	25.6
Moderate	Mild	-5.7	7.0	.416	-19.8	8.3
	Severe	6.8	8.1	.402	-9.4	23.1
Severe	Mild	-12.6	6.5	.058	-25.7	0.4
	Moderate	-6.8	8.1	.402	-23.1	9.4

Abbreviations: FBS, fasting blood sugar; PASI, psoriasis area and severity index; Sig, significance; Std, standard
(I) PASI_severity and (J) PASI_severity refer to psoriasis severity categories defined as mild (< 10), moderate (10–15), and severe (> 15)

The mean PASI score was higher in the non-DM group compared to the DM group (Table 4). The non-DM group (n = 58) had a mean PASI score of 8.4 ± 9.4 (95% CI: 5.9 to 10.8), with a range from 0.0 to 49.0. In contrast, the DM group (n = 7) had a significantly lower mean PASI score of 3.3 ± 0.7 (95% CI: 2.6 to 4.0), with a range from 2.2 to 4.5. The overall PASI score across all participants was 7.8 ± 9.0 .

DISCUSSION

The findings of this study suggest that FBS levels do not have a significant correlation with psoriasis severity, as measured by the PASI. Interestingly, the DM group demonstrated lower mean PASI scores compared to the non-DM group. This observation may be influenced by treatment-related factors. Some participants were already on blood-sugar lowering medications prior to the study. Previous research suggests that certain anti-diabetic medications may reduce psoriasis severity

in patients with DM. Specifically, anti-diabetic agents, such as thiazolidinediones, glucagon-like peptide-1 receptor agonists, dipeptidyl peptidase-4 inhibitors, and biguanides have been reported to significantly decrease psoriasis area and PASI scores from baseline.¹⁸ The use of these medications may have influenced FBS levels and could be a contributing factor to the statically non-significant relationship between FBS and PASI severity.¹⁹ However, detailed information regarding glucose-lowering medication class, dose, and duration was not consistently available in this retrospective dataset. Therefore, adjustment, stratification, or sensitivity analyses based on medication use could not be performed, and glucose-lowering therapy remains a potential confounder in interpreting the association between FBS and psoriasis severity.

Patients with diabetes are also often under closer medical supervision and may be more likely to receive systemic psoriasis therapy. Systemic treatments such as methotrexate or cyclosporine may reduce

Table 3 Descriptive Statistics Comparing Severity of Psoriasis and FBS (including mean and standard deviation)

	N	Mean	Std. Deviation	Std. Error	95 % Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Mild	36	109.4	27.6	4.6	100.1	118.8	77	192
Moderate	13	103.6	12.8	3.5	95.9	111.4	87	125
Severe	16	96.8	7.2	1.8	92.9	100.6	82	110
Total	65	105.2	22.1	2.7	99.7	110.6	77	192

Abbreviations: FBS, fasting blood sugar; N, number; Std, standard

Table 4 Descriptive Statistics of PASI Scores in the DM and Non-DM Groups

	N	Mean	Std. Deviation	Std. Error	95 % Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Non-DM	58	8.4	9.4	1.2	5.9	10.8	0.0	49.0
DM	7	3.3	0.7	0.2	2.6	4.0	2.2	4.5
Total	65	7.8	9.0	1.1	5.6	10.1	0.0	49.0

Abbreviations: DM, diabetes mellitus; FBS, fasting blood sugar; N, number; Std, standard

inflammatory burden and improve psoriasis severity. Therefore, concurrent systemic treatment may have masked the true clinical severity of psoriasis in the DM group, potentially attenuating any observable association between FBS and PASI scores in this cross-sectional analysis.

Several explanations may account for the lack of statistically significant association. FBS reflects short-term glycemic status and may not adequately capture chronic insulin resistance. Systemic psoriasis therapy and glucose-lowering medications may attenuate inflammatory burden and mask disease severity. Previous studies have reported inconsistent findings regarding PASI and metabolic parameters,^{2,10,11} suggesting that the interaction between psoriasis severity and glycemic status is complex and influenced by multiple confounders.

This study has several limitations. Data were collected from a single center, which may affect the generalizability of the findings. The relatively small number of patients in the DM subgroup ($n = 7$) may limit statistical power and increase the risk of type II error. The final analyzable sample ($n = 65$), which was slightly below the planned minimum sample size ($n = 70$), may have further reduced statistical power and limited the ability to detect small-to-moderate associations between FBS and PASI. Moreover, the retrospective cross-sectional design relied on available clinical data, limiting control over treatment exposure and laboratory timing. Because the association was evaluated using group comparisons across PASI severity categories rather than direct correlation or regression modeling, residual confounding cannot be excluded. Prospective longitudinal studies incorporating direct association analyses with adjustment for key covariates (e.g., age, sex, BMI), systemic psoriasis treatments, and glucose-lowering medications are warranted to better clarify potential causal relationships between glycemic status and psoriasis severity.

A multi-center study involving a larger and more diverse group of participants could provide more reliable insights into whether the association between FBS and PASI scores is consistent across different populations. Demographic factors, such as dietary habits and cultural differences within Thailand can influence the risk factors for metabolic syndrome, including elevated FBS levels.^{19,20} Therefore, variations in demographic characteristics and treatment practices might affect both FBS level and psoriasis severity. A multicenter approach could improve the validity and applicability of the findings. Although our analysis did not reveal a strong link between FBS and PASI scores, the link between psoriasis and metabolic comorbidities such as DM is well-established. DM is both a risk factor for psoriasis and a potential consequence of the disease.²¹ Future research should prioritize investigating psoriasis as an early indicator of DM. Monitoring FBS levels in psoriasis patients could help identify undiagnosed DM or prediabetes, enabling early intervention. Preventive measures, such as lifestyle changes, dietary adjustments, and early pharmacological interventions could help delay or prevent the onset of diabetes.

CONCLUSION

In conclusion, although this study did not reveal a statistically significant correlation between FBS levels and PASI severity, several factors need to be considered when interpreting these results, such as the use of blood sugar-lowering treatments by some participants and the limitations of a single-center study. Future research should explore the potential role of psoriasis in the preclinical diagnosis of DM and emphasize FBS monitoring in psoriasis patients as an early marker for DM in this population.

Conflict of Interest

The authors declare no conflict of interest.

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The authors declare that Artificial Intelligence (AI) tools were used only to assist with language editing of this manuscript. The authors remain fully responsible for the content, interpretation, and conclusions presented in this work.

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Data Availability Statement

The datasets generated or analysed during this study are available from the corresponding author upon reasonable request.

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ORIGINAL ARTICLE

Factors Associated With COVID-19 Vaccination Among Medical Students

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ABSTRACT

Objectives: This study aims to evaluate the factors associated with vaccine hesitancy and acceptance of COVID-19 vaccination among medical students at the Faculty of Medicine, Vajira Hospital, Navamindradhiraj University.

Materials and Methods: A cross-sectional study was conducted among medical students. Data were collected using a structured, self-administered online questionnaire developed based on Lucia et al. The questionnaire included sections on demographic characteristics, perceptions and attitudes toward COVID-19 and COVID-19 vaccination, experience with COVID-19 infection, and vaccination behavior. Binary logistic regression analysis was performed to identify factors associated with vaccine hesitancy with the significant level of $p < 0.05$

Results: A total of 298 medical students participated in the survey, a response rate of 54.3%. Among the participants, 57.7% were male, 77.9% were in the preclinic, and 60.7% had a Grade Point Average classified as very good. Most of the participants (81.5%) reported to take the COVID-19 vaccine as soon as Food and Drug Administration approved is available. Almost all the participants would recommend the COVID-19 vaccine to family and friends (98.7%), to their patients (96.6%), and to the communities (98.3%). The vaccine acceptance group is significantly associated with the participants views that the COVID-19 vaccination is important for them as a healthcare provider (adjust odd ratio (OR) = 10.82, 95% confidence interval (CI) 1.09-107.08, p -value = 0.042*) and the trust of information related to COVID-19 vaccine from public health experts (adjust OR = 2.58, 95% CI 1.23-5.20, p -value = 0.009*) However, the serious side effects of the vaccine is significantly associated with the vaccine hesitancy (adjust OR = 0.31, 95% CI 0.14-0.69, p -value = 0.004*).

Conclusion: Medical students exhibited a positive attitude toward the COVID-19 vaccine. However, the serious effects of the vaccine also associated with the vaccine hesitancy. Medical schools could emphasis vaccine-related education, focusing on the safety and potential consequences of vaccines to ensure students are confident in addressing vaccine-related issues

Keywords: attitude, covid-19 pandemic, covid-19 vaccination, medical student

INTRODUCTION

The COVID-19 pandemic, caused by the SARS-CoV-2 virus,¹ has emerged as one of the most significant global public health crises in recent history. First identified in December 2019 in Wuhan, China, the virus rapidly spread worldwide, including Thailand. COVID-19 primarily affects the human respiratory system, with transmission occurring via respiratory droplets, airborne particles, and direct contact.² The infection can lead to life-threatening conditions and other complications, such as respiratory failure, acute respiratory distress syndrome, sepsis, septic shock, thromboembolism, and multiorgan failure, including acute kidney injury and cardiac injury.³ The pandemic has resulted in widespread illness, substantial loss of life, and severe economic and social disruptions. Consequently, healthcare systems have been overwhelmed by a surge in infected patients, placing significant strain on resources. The World Health Organization launched a pandemic protocol, which led to the activation of necessary public health measures, including lockdowns, social distancing, and mask mandates, to mitigate the spread of COVID-19.⁴ According to the Center for Covid-19 Situation Administration,⁵ Ministry of Public Health of Thailand on March 12, 2021, the epicenters of the pandemic were Bangkok and Samut Sakhon, urban area in Thailand. At that time, 97.7% (26,056) of cases were treated, 0.3% (85) resulted in death, and 2% (538) were admitted to hospitals or isolated (412 individuals in hospitals and 126 in field hospitals).

Vaccination is an essential tool in disease prevention, particularly during pandemics as it helps establish herd immunity and prevent the spread of infectious diseases. During the crisis, healthcare professionals are typically among the first to receive the vaccine, not only to protect themselves but also to reduce the transmission of the disease to others. Although vaccines have been shown to effectively reduce infection rates, the vaccination coverage remains relatively low, with only 55%-82% among the population.⁶ Still, vaccine hesitancy remains a significant challenge affecting vaccination rate.⁷ Attitudes toward vaccination among healthcare professionals are associated with addressing vaccine-related challenges through confident counselling and recommendations. As a result, strong advice from healthcare professionals could significantly increase vaccination rates.⁸

Medical students, as an integral part of healthcare system and also a future physician, are in a position to influence public health awareness, particularly in the

promotion of vaccination. As part of their training, medical curricula provide education on vaccines, including their mechanisms of action and national guidelines for each vaccination program aiming to ensure that medical students have sufficient knowledge to advocate for and counsel patients on vaccines, including the COVID-19 vaccine. While medical curricula aim to promote vaccine knowledge and foster vaccine acceptance, recent studies have demonstrated vaccine hesitancy among medical students, which could undermine vaccination efforts and contribute to increased morbidity and mortality rates from infectious diseases.⁹ Attitudes toward vaccination are recognized as important determinants of health-related behaviors. According to behavioral theories, individuals' perceptions, beliefs, and concerns regarding vaccines may influence their acceptance or hesitancy.⁹

This study aims to evaluate medical students' attitude toward COVID-19 vaccination and the factors associated with vaccine hesitancy and acceptance in an urban setting at the Faculty of Medicine Vajira Hospital, Navamindradhiraj University. This information could provide valuable insights into medical students' attitude and concern about vaccination as well as guide the development of educational programs that equip students with the necessary knowledge to make informed decisions. Additionally, it could help address vaccine hesitancy among patients by ensuring that medical students are better prepared to counsel and support vaccine-hesitant individuals.

MATERIALS AND METHODS

This cross-sectional survey design was conducted among first to sixth year medical students at Faculty of Medicine, Vajira Hospital, Navamindradhiraj University from September 2021 to January 2022. The study was approved by the Institutional Review Board, Faculty of Medicine Vajira Hospital, Navamindradhiraj University (COA 159/2564). Eligible participants were first- to sixth- year medical students enrolled in the 2021 academic year who were aged 18 years or older, able to read Thai, and voluntary to participate in the study. The sample size was calculated using a finite population proportion formula to achieve the power level.¹⁰ Data were collected through a self-administered online survey. Participants were provided with a QR code linking to an information sheet, and electronic informed consent was obtained before participation.

The questionnaire was developed based on the study by Lucia et al.¹¹ and translated into Thai using a

forward-backward translation process to ensure conceptual equivalence with the original version. The translated questionnaire was reviewed by experts in public health and medical education to assess content validity before data collection. The final questionnaire consisted of five sections: Section 1 was demographic characteristics. This section included six items assessing sex, academic year (pre-clinical or clinical level), underlying diseases, grade point average (GPA), health insurance coverage, and hometown. Section 2 was general perceptions about vaccines. This section included two items measured using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Section 3A was knowledge and perceptions regarding COVID-19 and COVID-19 vaccines. This section consisted of six Likert-scale items assessing perceived importance of vaccine development, public health impact, occupational exposure risk, and trust in public health information. Section 3B was attitudes toward COVID-19 vaccination. This section included five Likert-scale items evaluating concerns regarding vaccine efficacy, potential side effects, and opinions on mandatory vaccination policies. For Sections 2–3B, higher scores indicated more positive attitudes toward COVID-19 vaccination. Negatively worded items were reverse-scored prior to analysis. Section 4 was experience with COVID-19 infection. This section consisted of four dichotomous (Yes/No) questions assessing personal infection history and related experiences. Section 5 was vaccination behavior and intention. This section included four dichotomous (Yes/No) questions evaluating vaccine acceptance and recommendation behavior. The internal consistency of the Likert-scale sections (Sections 2–3B) was assessed using Cronbach's alpha. The reliability coefficient was 0.766, indicating acceptable internal consistency in this study population. The questionnaire was administered via an online survey platform in which all items were mandatory. Participants were unable to submit the questionnaire without completing all questions; therefore, no missing data were present in the final dataset.

The primary dependent variable was vaccine hesitancy, defined as a binary outcome based on participants' responses regarding willingness to receive COVID-19 vaccination. Independent variables included demographic characteristics (academic year, GPA, underlying disease, and hometown), attitudinal variables toward COVID-19 and COVID-19 vaccination measured using Likert-scale items, and COVID-19-related experience variables (e.g., prior infection or exposure). Categorical

variables were coded appropriately for regression analysis. GPA was dichotomized at ≥ 3.50 to reflect high academic performance. Attitudinal variables were treated according to their scale distribution.

Demographic data, personal vaccination behavior, and their experience with COVID-19 were analyzed and reported using descriptive statistic. GPA was dichotomized at ≥ 3.50 according to institutional academic performance standards. Sensitivity analyses using alternative categorizations yielded similar adjusted odds ratios. Personal views on COVID-19 and vaccine were reported by frequency (%) with a 95% confidence interval (CI). Factors associated with vaccine acceptance and vaccine hesitancy were analyzed using Pearson's Chi-square test, Fisher's exact test, and Binary logistic regression to identify significant associations. Variables were selected for multivariable logistic regression based on theoretical relevance and univariable screening ($p < 0.20$). Underlying disease was not included in the final model due to lack of significant association and to avoid overfitting given its multiple categories. The multivariable logistic regression analysis was performed using the full sample ($n = 298$). The reduced sample size observed in the gender characteristic table ($n = 291$) reflects non-response to that specific item only model stability was assessed using the events-per-variable (EPV) approach as recommended by Vittinghoff et al. With 55 events and three predictors included, the EPV was 18.3, exceeding recommended thresholds. Data were analyzed using IBM SPSS Statistics for Windows, version 26.0 Armonk, NY, USA: IBM Corp. at a statistical significance of $p < 0.05$.

RESULTS

A total of 298 questionnaire responses were obtained out of 548 medical students, resulting in a response rate of 54.3%, and the demographic data of the participants are presented in [Table 1](#). The majority of participants were male, accounting for 57.7%. Most of the participants were in the pre-clinical years (77.9%), which included first- to third-year medical students. Over half of the participants (60.7%) had a very good GPA. The most common underlying diagnosis was allergic rhinitis, reported by 33.6% of participants. The majority of the participants were covered by the Universal Health Coverage Scheme (53.7%), and most of the participants were from Bangkok (81.2%).

Behavior toward COVID-19 vaccination presents in [Table 2](#). Most of the participants (81.5%) reported

Table 1 Characteristic of Participants (n = 298)

Characteristics	n = 298	%
Gender		
Female	119	39.9
Male	172	57.7
Not specific	7	2.3
Year in medical school		
Pre-clinical year (1 st -3 rd year)	232	77.9
Clinical year (4 th -6 th year)	66	22.1
Underlying disease		
Asthma	7	2.3
Allergic rhinitis	100	33.6
Obesity (BMI > 30.00)	16	5.4
Others	175	58.7
Grade point average		
4.00	18	6.0
3.50-3.99	181	60.7
3.00-3.49	79	26.5
2.50-2.99	17	5.7
2.00-2.49	3	1.0
< 1.99	0	0
Medical rights		
Government service fund	51	17.1
Social security fund	25	8.4
Universal coverage scheme	160	53.7
Self-pay	62	20.8
Hometown		
Bangkok (urban area)	242	81.2
Others	56	18.8

Abbreviations: BMI, body mass index; n, number

to take the COVID-19 vaccine as soon as Food and Drug Administration (FDA) approved is available. Additionally, almost all the participants prefer to recommend the COVID-19 vaccine to family and friends (98.7%), to their patients (96.6%), and to the communities (98.3).

Table 3 demonstrated the bivariate analysis of factors associated between vaccine acceptance or

vaccine hesitancy and (1) characteristic of participants, (2) personal views on COVID-19 and vaccine and (3) Experiences with COVID-19. Firstly, the bivariate analysis shows that characteristic of participants including gender (p-value = 0.352), year in medical school (p-value = 0.450), GPA (p-value = 0.559), their medical rights (p-value = 0.413), and hometown (p-value = 0.684) were not significantly associated with vaccine acceptance or hesitancy.

Secondly, personal views on COVID-19 and vaccine illustrated that nearly all participants (81.8%) consider that vaccine are important for their health as the will be a future physician (p-value = 0.442). The majority of the participants (81.1%) agree that their role as future physician to learn about vaccine both for themselves and their patients. In the aspect of COVID-19 vaccine, the vast majority of the participants (81.4%) agree that the development of COVID-19 vaccine is important to decrease the spread of disease (p-value = 0.348) as well as its important for the public health of our communities. 81.7% among the vaccine acceptance group agree that they will likely to be exposed to COVID as a future physician (p-value = 0.921). Additionally, the vaccine acceptance group is significantly associated with the participants views that the COVID-19 vaccination is important for them as a healthcare provider (adjust odd ratio (OR) = 10.82, 95% CI 1.09-107.08, p-value = 0.042*). Moreover, the vaccine acceptance group is statistically associated with the trust of information related to COVID-19 vaccine from public health experts (adjust OR = 2.58, 95% CI 1.23-5.20, p-value = 0.009*). However, the majority of the participants (81.3%) agree that they need more information about COVID-19 vaccine (p-value = 0.276) as well as they agree on the concerned point about COVID-19 vaccine such as the vaccine may not be effective (p-value = 0.656) and the serious side effects of the vaccine is significantly associated with the vaccine hesitancy (adjust OR = 0.31, 95% CI 0.14-0.69, p-value = 0.004*). Lastly, the majority of the participants agree that COVID-19 vaccination should be mandatory for the public (p-value = 0.669) as well as for all healthcare providers (p-value = 0.313).

Thirdly, experiences related to COVID-19, including personal acquaintance with COVID-19 patient (p-value = 0.128), experience in care for COVID-19 patients (p-value = 0.245), and personally known COVID-19 patient with mortality (p-value = 0.999), were not associated with vaccine acceptance or hesitancy.

Table 2 Behavior Toward COVID-19 Vaccination

Survey Items	Yes n, (%)	No n, (%)
I will take the COVID-19 vaccine as soon as an FDA approved vaccine is available.	243, (81.5)	55, (18.5)
I would recommend the COVID-19 vaccine to family and friends.	294, (98.7)	4, (1.3)
I would recommend the COVID-19 vaccine to my patient.	288, (96.6)	10, (3.4)
I would recommend the COVID-19 vaccine to the community.	293, (98.3)	5, (1.7)

Abbreviations: FDA, food and drug administration; n, number

Table 3 Factors Associated With COVID-19 Vaccination

Factors	Vaccine Acceptance n (%)	Vaccine Hesitancy n (%)	Crude OR	P-value	Adjusted OR	P-value
Characteristic of participants						
Gender (n = 291)				0.246		0.352
Female	94 (79.0)	25 (21.0)	1		1	
Male	145 (84.3)	27 (15.7)	1.43 (0.78–2.61)		1.39 (0.70–2.75)	
Year in medical school (n = 298)				0.137		0.450
Pre-clinic	185 (79.7)	47 (20.3)	1		1	
Clinic	58 (87.9)	8 (12.1)	1.84 (0.82–4.12)		1.42 (0.57–3.53)	
Grade point average (n = 298)				0.931		0.559
≥ 3.50	162 (81.4)	37 (18.6)	1		1	
< 3.50	81 (81.8)	18 (18.2)	1.03 (0.55–1.92)		0.80 (0.38–1.68)	
Medical rights (n = 298)				0.096		0.413
Government service fund, Social security fund, Universal coverage scheme	197 (83.5)	39 (16.5)	1		1	
Self-pay	46 (74.2)	16 (25.8)	0.57 (0.29–1.11)		0.72 (0.33–1.58)	
Hometown (n = 298)				0.898		0.684
Bangkok and urban area	197 (81.4)	45 (18.6)	1		1	
Others	46 (82.1)	10 (17.9)	1.05 (0.49–2.24)		1.19 (0.51–2.79)	
Personal views on COVID-19 and vaccine (n = 298)						
1. Vaccines are important for me to stay healthy as a future physician				0.662		0.442
Disagree	10 (76.9)	3 (23.1)	1		1	
Agree	233 (81.8)	52 (18.2)	1.34 (0.36–5.06)		1.94 (0.36–10.55)	

Table 3 Factors Associated With COVID-19 Vaccination (cont.)

Factors	Vaccine Acceptance n (%)	Vaccine Hesitancy n (%)	Crude OR	P-value	Adjusted OR	P-value
2. It is my role as a future physician to learn about vaccines for myself and my patients				n/a		
Disagree	7 (100.0)	0 (0.0)	1			
Agree	236 (81.1)	55 (18.9)	n/a			
3. The development of a COVID-19 vaccine is important to decrease the spread of the disease				0.774		0.348
Disagree	6 (85.7)	1 (14.3)	1		1	
Agree	237 (81.4)	54 (18.6)	0.73 (0.09–6.20)		0.22 (0.01–5.26)	
4. COVID-19 vaccination is important for the overall public health of our communities				0.774		
Disagree	6 (85.7)	1 (14.3)	1			
Agree	237 (81.4)	54 (18.6)	0.73 (0.09–6.20)			
5. I am likely to be exposed to COVID as a future physician				0.763		0.921
Disagree	15 (78.9)	4 (21.1)	1		1	
Agree	228 (81.7)	51 (18.3)	1.19 (0.38–3.74)		0.93 (0.21–4.16)	
6. COVID-19 vaccination is important for me as a health care provider				0.631		0.042*
Disagree	6 (75.0)	2 (25.0)	1		1	
Agree	237 (81.7)	53 (18.3)	1.49 (0.29–7.59)		10.82 (1.09–107.08)	
7. I need more information about the COVID-19 vaccine				0.681		0.276
Disagree	17 (85.0)	3 (15.0)	1		1	
Agree	226 (81.3)	52 (18.7)	0.77 (0.22–2.71)		0.37 (0.06–2.23)	
8. I trust the information I am receiving about the COVID-19 vaccine from the public health experts				0.016*		0.008*
Disagree	85 (74.6)	29 (25.4)	1		1	
Agree	158 (85.9)	26 (14.1)	2.07 (1.15–3.75)		2.58 (1.28–5.20)	
9. I am concerned that a COVID-19 vaccine may not be effective				0.645		0.656
Disagree	83 (83.0)	17 (17.0)	1		1	
Agree	160 (80.8)	38 (19.2)	0.86 (0.46–1.62)		1.19 (0.55–2.60)	
10. I am concerned about the serious side effects of a COVID-19 vaccine				0.041*		0.004*
Disagree	103 (87.3)	15 (12.7)	1		1	
Agree	140 (77.8)	40 (22.2)	0.51 (0.27–0.97)		0.31 (0.14–0.69)	
11. The COVID-19 vaccination should be mandatory for the public				0.080		0.669
Disagree	84 (76.4)	26 (23.6)	1		1	
Agree	159 (84.6)	29 (15.4)	1.70 (0.94–3.07)		1.23 (0.47–3.21)	

Table 3 Factors Associated With COVID-19 Vaccination (cont.)

Factors	Vaccine Acceptance n (%)	Vaccine Hesitancy n (%)	Crude OR	P-value	Adjusted OR	P-value
12. The COVID-19 vaccination should be mandatory for all health care providers				0.012*		0.313
Disagree	53 (71.6)	21 (28.4)	1		1	
Agree	190 (84.8)	34 (15.2)	2.21 (1.19–4.13)		1.66 (0.62–4.43)	
13. The only reason I will get a COVID-19 vaccine is if it is mandated by the health system/medical school				0.409		0.602
Disagree	196 (80.7)	47 (19.3)	1		1	
Agree	47 (85.5)	8 (14.5)	1.41 (0.62–3.18)		1.28 (0.51–3.24)	
Experiences with COVID-19						
1. I had a history of COVID-19 infection				n/a		
Yes	237 (81.2)	55 (18.8)	1			
No	6 (100.0)	0 (0.0)	n/a			
2. I personally know someone who has had a COVID-19 infection				0.208		0.128
Yes	101 (78.3)	28 (21.7)	1		1	
No	142 (84.0)	27 (16.0)	1.46 (0.81–2.62)		1.71 (0.86–3.39)	
3. I have experience of care for a COVID-19 infection patient				0.366		0.245
Yes	226 (81.0)	53 (19.0)	1		1	
No	17 (89.5)	2 (10.5)	1.99 (0.45–8.89)		3.86 (0.40–37.59)	
4. I personally know someone who has died from COVID-19 infection				0.673		0.999
Yes	221 (81.3)	51 (18.8)	1		1	
No	22 (84.6)	4 (15.4)	1.27 (0.42–3.84)		1.00 (0.29–3.48)	

Abbreviations: n, number; OR, odd ratio

* Binary logistic regression, significant level at < 0.05, adjusted for all variables except U/D, question 2,4 section 2, and question 1 section 3

DISCUSSION

This study was conducted during the COVID-19 pandemic in Thailand. A total of 298 questionnaire responses were collected from 548 first- to sixth- year medical students, resulting in a response rate of 54.3%. The respond rate was higher than the previous study by Lucia et al.,¹¹ which demonstrated the respond rate of 34%. The higher response rate observed in this study may be attributed to the lock down period, as pre-clinical year students (77.9%) were likely more available to complete the survey compared to clinical year students (22.1%) within the medical student cohort.

Most of the participants (81.5%) indicated a willingness to receive the vaccine as soon as it became available following FDA approval. As FDA approval serves as a mandatory requirement for individuals to receive vaccines, this approval could consider a critical step in the authorization of medications. The finding is congruence with the study from Victoria C. Lucia et al.¹¹ demonstrated that 77% of their participants, medical students, preferred to receive COVID-19 vaccine as soon as the FDA approval available. However, nearly one-fifth of the participants (18.5%) would not receive the COVID-19 vaccine as soon as FDA approval. This

could be related to the personal views on COVID-19 vaccine, such as the participants still concerned about the efficacy of the vaccine and its serious side effects.

Additionally, almost all of participants indicated a willingness to recommend the COVID-19 vaccine to their family and friend (98.7%), their patients (96.6%), and the community (98.3%). These finding are consistent a study conducted among medical students by Afonso et al.,¹² which reported that 82% of participants would recommend the COVID-19 vaccine to others. This result highlights positive attitudes toward promoting vaccination. Despite not having completed their degree, the majority of participants demonstrated a strong sense of willingness to advocate for the vaccine within their role as future healthcare professionals.

Participants characteristics, including gender, year in medical school, GPA, medical rights, and hometown, were not statistically associated with vaccine acceptance and hesitancy. Additionally, experiences with COVID-19—such as such as a history of infection, knowing someone personally infected with COVID-19, providing care for a COVID-19 patient, or knowing someone who died from the infection—were also not statistically associated with vaccine acceptance or hesitancy. These finding are similar to a study among medical students in India¹³ which demonstrated that participants characteristics and the experiences with COVID-19 were not associated with vaccine hesitancy. While the efficacy and serious side effect were demonstrated a statistically significant with vaccine hesitancy.

There are three factors associated with vaccine acceptance (1) COVID-19 vaccination is important for me as a healthcare provider (2) I trust the information I am receiving about the COVID-19 vaccine from the public health expert (3) I am concerned about the serious side effect of a COVID-19 vaccine. According to the regression model, vaccine acceptance is associated with the belief that COVID-19 vaccination is important for their role as healthcare providers. This finding is discordance with the study by Lucia et al.,¹¹ which presented that the importance of vaccination for their role of healthcare provider were not associated with vaccine acceptance. This could be influence by the difference between the Thai's medical curriculum, which medical students are also part of healthcare service. The Thai medical students who are in their clinical year will be experiences patients-visit under supervision. This could be highlighting that among our participant, the Thai medical students are also consider themselves as

healthcare provider. Therefore, medical schools should provide both information and service for medical students as part of healthcare provider.

Our study demonstrated that vaccine acceptance among medical students is associated with trust in information provided by public health experts. This finding aligns with the a study among medical students in the US,¹¹ which reported that the vaccine acceptance were associated to trust in information from the public health authorities. Similarly to the study among the US adults illustrated that a lack of trust among the participants was associated with vaccine hesitancy.¹⁴ This finding emphasizes the important role of public health experts in influencing medical students. Advocacy from government health authorities could serve as a key factor in guiding medical students and empowering healthcare professionals to adopt effective disease prevention strategies.

Importantly, concerns about serious side effects of the COVID-19 vaccine were associated with vaccine hesitancy. This finding is consistent with the studies conducted in France,¹⁵ Romania,¹⁶ and the US,¹¹ which highlighted that the unforeseeable and serious side effect are significantly associated with vaccine hesitancy. Additionally, Kernéis et al.¹⁵ highlighted the importance of providing adequate vaccine education and preparing future physicians to effectively communicate with patients about vaccine-related benefits and risks. Since vaccines play a crucial role in disease prevention, this finding highlights the importance of acknowledging potential adverse events among medical students. Transparency and effective communication about potential risks can empower individuals with sufficient information to make informed decisions. Incorporating this information into medical curricula, particularly during crises such as pandemics or the emergence of new diseases, would further enhance awareness and preparedness among future healthcare professionals. Similar to previous research, healthcare workers should be equipped with the skills to recommend the COVID-19 vaccine and provide reassurance to patients.¹⁷

The strength of this study lies in identifying factors associated with COVID-19 vaccination among medical students, which can be utilized to improve health literacy and empower medical students to advocate for increased vaccine uptake and address existing challenges. This study was a cross-sectional study conducted at a medical school and, therefore, may not be generalizable to other medical schools across Thailand. Additionally, this study employed binary

logistic regression to identify factors associated with vaccine hesitancy. While this approach allowed for clear interpretation of independent associations, alternative analytical strategies may provide a more comprehensive understanding of the relationship between attitudes and vaccination behavior. Future research with larger sample sizes may explore these advanced approaches. Furthermore, the quantitative design is limited to identifying associations but cannot capture the underlying reasons behind these associations. Future studies could adopt a qualitative approach to explore the reasons for vaccine hesitancy in greater depth, which could help address gaps and provide medical students with sufficient information to effectively counsel patients about receiving vaccines, as well as to ensure they fully understand the risks and benefits associated with vaccination.

CONCLUSION

During the COVID-19 pandemic, the majority of medical students demonstrated a willingness to receive the COVID-19 vaccine, recognizing its critical role in disease prevention and achieving herd immunity. Most participants acknowledged the importance of vaccination not only for their personal protection but also in fulfilling their roles as future healthcare providers. Furthermore, medical students expressed trust in information provided by public health experts. However, concerns about serious side effects were identified as a factor associated with vaccine hesitancy. To address these concerns, medical curricula should incorporate evidence-based information from experts, focusing on vaccine safety and effectiveness. Enhancing educational programs can promote vaccine uptake and better prepare medical students to advocate for vaccination within their professional roles.

Conflict of Interest

The authors have no conflict of interest. This study is sponsored by the Research Facilitation Division, Faculty of Medicine Vajira Hospital, Navamindradhiraj University. This research receives grant from funding of the Faculty of Medicine Vajira Hospital, Navamindradhiraj University research fund, Bangkok, Thailand.

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Investigation: WP

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Data Availability Statement

The data that support the findings of this study are available upon request from basmon@nmu.ac.th.

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ORIGINAL ARTICLE

Restoration of Preoperative Coronal Plane Alignment of the Knee Phenotypes and Clinical Outcomes Following Mechanically Aligned Total Knee Arthroplasty

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ABSTRACT

Objectives: This study aimed to determine the proportion of patients who exhibited a change in their coronal plane alignment of the knee (CPAK) classification after mechanically aligned (MA) total knee arthroplasty (TKA) and compare postoperative clinical outcomes between patients who restored their preoperative CPAK classification and those who did not.

Materials and Methods: This was a retrospective cohort study including 194 knees from 143 patients who underwent MA TKA between December 2021 and June 2024. Radiographic parameters, including pre- and postoperative lateral distal femoral angle and medial proximal tibial angle, were measured using long-leg standing radiographs to determine the CPAK classification. Postoperative Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores, range of motion (ROM), and surgical complications were recorded.

Results: The most common preoperative CPAK classification was type I (40.7%), followed by type II (22.7%) and type IV (14.9%). Furthermore, 36 (18.6%) knees were restored to their preoperative CPAK classification. No significant differences in postoperative ROM (flexion: 115° vs. 110°, $p = 0.445$; extension: 5° vs. 5°, $p = 0.770$) and WOMAC scores (13.56 ± 9.58 vs. 18.12 ± 10.64 , $p = 0.251$) were observed between the restored and non-restored groups. The surgical complication rates were 2.7% and 5.7% in the restored and non-restored groups, respectively.

Conclusion: A fixed MA TKA target may alter patients' CPAK classification post-operatively, with only a limited proportion achieving restoration of their preoperative CPAK classification. Restoration of the preoperative CPAK classification did not significantly influence clinical outcomes.

Keywords: coronal plane alignment, coronal plane alignment of the knee classification, mechanically aligned total knee arthroplasty, total knee arthroplasty

INTRODUCTION

Total knee arthroplasty (TKA) is the standard treatment for advanced knee osteoarthritis (OA). However, 10%–20% of patients reported dissatisfaction with surgical outcomes.¹ Several factors have been identified as contributing to persistent dissatisfaction after TKA, including younger age, poor preoperative psychological status, chronic opioid use, residual postoperative pain, limited postoperative range of motion (ROM), and changes in coronal knee alignment after surgery.^{2–6}

Historically, the restoration of coronal knee alignment to a neutral mechanical axis has been the primary goal in TKA.⁷ However, there is growing interest in the coronal plane alignment of the knee (CPAK) classification, and evidence suggests that postoperative changes from a patient's preoperative CPAK type may contribute to suboptimal outcomes.^{8,9}

The CPAK classification, introduced by Macdessi et al., categorizes knees into nine phenotypes based on constitutional limb alignment and joint line obliquity (JLO).¹⁰ Traditionally, surgeons perform mechanically aligned (MA) TKA using conventional instruments to cut the distal femur and proximal tibia perpendicular to their respective mechanical axes, aiming to achieve a neutral hip–knee–ankle (HKA) angle and a neutral JLO, consistent with CPAK type V. However, the most prevalent CPAK classification among Asian patients with knee OA is type I (varus HKA angle and apex-distal JLO; 49.3%–53.8%), followed by type II (neutral HKA angle and apex-distal JLO; 20.6%–25.4%) and type V (4%–5%).^{11,12} Targeting a neutral mechanical alignment may alter a patient's preoperative CPAK classification. However, this is not always achieved due to inaccuracies associated with conventional instruments, with up to 26%–30% of cases reported as outliers.^{13,14}

Despite the limited precision of conventional instruments in achieving a neutral mechanical axis, they may inadvertently restore a patient's preoperative CPAK classification. However, this phenomenon has been examined in only a limited number of studies. Corban et al. reported that, with conventional instrumentation in MA TKA, only 13% of patients coincidentally matched their preoperative CPAK type.¹⁵ Notably, these findings were derived from a non-Asian population, which may differ in the native CPAK distribution from Asian populations.

This study aimed to investigate the proportion of patients who exhibited a change in their CPAK classification after MA TKA. Additionally, this study

aimed to describe the distribution of CPAK classification among patients with knee OA undergoing TKA and compare postoperative clinical outcomes between patients who restored their original CPAK classification and those who did not.

MATERIALS AND METHODS

This retrospective study was approved by the Institutional Review Board of our institution (COA 174/68). This study included consecutive patients who underwent primary MA TKA performed by a fellowship-trained arthroplasty surgeon (PW) between December 2021 and June 2024. Patient data were obtained from the institution's electronic medical records and radiographic databases. The data were retrospectively retrieved using a standardized collection form and were collected by the primary author (PW). Patients who received a constrained TKA prosthesis, those who had severe preoperative bone loss, those who underwent computer navigation- or robotic-assisted surgery, and those who had incomplete radiographic data were excluded from the study.

A midvastus arthrotomy was performed. Then, the anterior cruciate ligament and osteophytes were excised. The proximal tibia was resected perpendicular to its anatomical axis using an extramedullary guide, whereas the distal femur was resected using an intramedullary guide set at a valgus angle of 5°. The extension gap was assessed using a spacer block. Medial soft-tissue release was performed as needed to achieve a symmetrical extension gap, whereas lateral release was performed for valgus knees. The femoral component size was determined using the anterior referencing technique, whereas the flexion gap and femoral rotation were assessed based on soft-tissue tension. Anterior, posterior, and chamfer cuts of the femur were performed. Trial components were inserted, and tibial tray rotation was determined using the self-aligned technique. Patellar tracking was evaluated using the no-thumb technique. All components were cemented, and an appropriately sized polyethylene insert was placed.

Preoperatively, all patients underwent standardized true anteroposterior (AP) and lateral knee radiographs, along with full-length standing radiographs, using a digital radiography system (Ysio Max, Siemens Healthineers, Germany). Postoperatively, true AP and lateral radiographs were obtained on the first postoperative day, and full-length standing radiographs were acquired at four weeks.

Radiographic parameters, including lateral distal femoral angle (LDFA) and medial proximal tibial angle (MPTA), were measured using preoperative and postoperative full-length standing radiographs. The LDFA was measured as the lateral angle formed between the mechanical axis of the femur, and the distal femoral joint line. The femoral mechanical axis was defined as a line connecting the center of the femoral head to the most proximal point of the distal femoral intercondylar fossa, while the distal femoral joint line was defined as a line connecting the most distal points of the medial and lateral femoral condyles.

The MPTA was measured as the medial angle formed between the mechanical axis of the tibia and the proximal tibial joint line. The tibial mechanical axis was defined as a line connecting the center of the tibial intercondylar eminence to the center of the talus, whereas the proximal tibial joint line was defined as a line connecting the most proximal points of the medial and lateral tibial plateaus.

All measurements were performed twice by a single unblinded observer (PW), with a one-week interval, using the institution's digital picture archiving and communication system (EVInsight, PSP Co., Ltd., Thailand). The average values were used for analysis. The intraclass correlation coefficients for preoperative

LDFA, preoperative MPTA, postoperative LDFA, and postoperative MPTA were 0.928, 0.931, 0.849, and 0.916, respectively, indicating good to excellent intraobserver reliability.

The CPAK classification was determined based on the arithmetic HKA (aHKA) angle and JLO derived from LDFA and MPTA as previously described.¹⁰ The aHKA angle was calculated as $MPTA - LDFA$. aHKA angle $< -2^\circ$ was categorized as varus, between -2° and 2° as neutral, and $> 2^\circ$ as valgus. JLO was calculated as $MPTA + LDFA$. JLO $< 177^\circ$ was classified as apex-distal, between 177° and 183° as apex-neutral, and $> 183^\circ$ as apex-proximal. Patients were categorized into a CPAK classification based on their aHKA and JLO values (Figure 1). The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire score was obtained by an independent observer. ROM was measured using goniometer by the treating team, and surgical complications were recorded at the latest follow-up.

Normally distributed continuous data were presented as mean and standard deviation, and between-group comparisons were performed using the independent t-test. Non-normally distributed data were presented as median and interquartile range, and between-group comparisons were performed using

		Arithmetic HKA (aHKA=MPTA-LDFA)		
		VARUS	NEUTRAL	VALGUS
Joint line obliquity (JLO=MPTA+LDFA)	APEX DISTAL	Type I	Type II	Type III
	NEUTRAL	Type IV	Type V	Type VI
	APEX PROXIMAL	Type VII	Type VIII	Type IX

Figure 1 CPAK Classification Comprising Nine Phenotypes Based on JLO and aHKA

the Mann–Whitney U test. Categorical variables were presented as absolute numbers and percentages. Statistical analysis was performed using IBM SPSS Statistics for Windows version 31.0 (IBM Corp., Armonk, NY, USA). A p -value < 0.05 was considered statistically significant.

RESULTS

A total of 194 knees from 143 patients were included in this study (**Figure 2**). **Table 1** shows patients' demographic characteristics. The most common preoperative CPAK classification was type I (40.7%), followed by type II (22.7%) and type IV (14.9%), with the remainder distributed across type III and V–IX (**Figure 3**).

After MA TKA, the most common CPAK classification was type V (38.7%), followed by type IV (24.7%) and type VI (10.3%), with the remaining knees distributed across types I–III and VII–IX (**Figure 4**). Overall, 18.6% ($n = 36$) of the knees were restored to their preoperative CPAK classification postoperatively. Restoration was most frequently observed in knees with a neutral JLO. Among the subgroups, CPAK type VI showed the highest restoration rate (75%), followed by type V (60%) and type IV (45%); the distribution of the remaining types is presented in **Figure 5**. The preoperative and postoperative radiographic parameters according to CPAK classification are presented in **Table 2 and 3**.

The mean follow-up durations were 1.48 ± 0.97 years and 1.43 ± 0.96 years for the restored and non-restored preoperative CPAK classification groups, respectively. No significant differences in postoperative ROM were observed between the two groups (flexion: 115° vs. 110° , $p = 0.445$; extension: 5° vs. 5° , $p = 0.770$). The complete case analysis comparing

Table 1 Patients' Demographic Characteristics

Parameters	Values
Mean age, years (SD)	68.5 (5.1)
Gender	
Female, % (n)	82.5% (118)
Side	
Right, % (n)	48.4% (94)
Mean BMI, kg/m ² (SD)	26.5 (3.8)
Kellgren–Lawrence classification	
2, % (n)	14.5% (28)
3, % (n)	54.1% (105)
4, % (n)	31.4% (61)
Prosthesis design	
PFC sigma	90.2% (175)
Triathlon	9.8% (19)

Abbreviations: BMI, body mass index; kg, kilograms; m², square meter; n, number; PFC, press fit condylar; SD, standard deviation

WOMAC scores included 9 patients in the restored group and 34 in the non-restored group. Imputation was not performed for missing data. No significant difference in the mean WOMAC scores was observed between the two groups (13.56 ± 9.58 vs. 18.12 ± 10.64 ; $p = 0.251$). Postoperative complications occurred in 13 (5.7%) patients in the non-restored group,

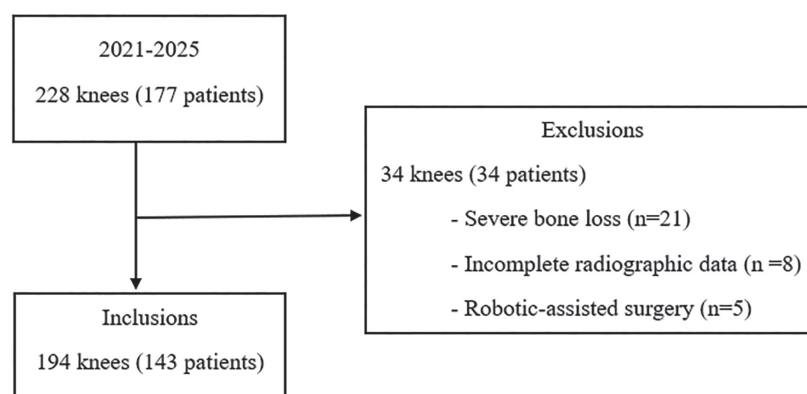


Figure 2 Study Flowchart

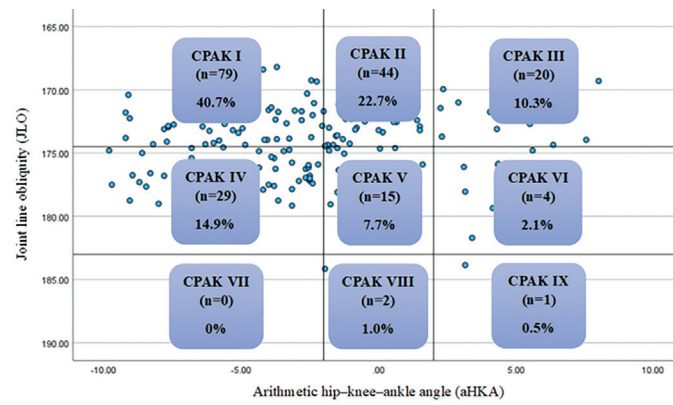


Figure 3 Preoperative CPAK Classification

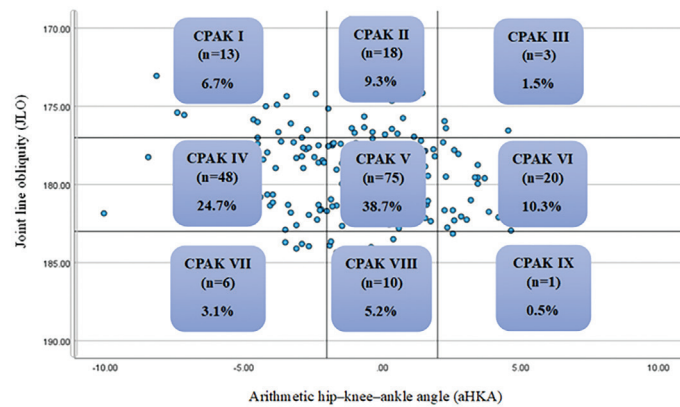


Figure 4 Postoperative CPAK Classification After MA TKA

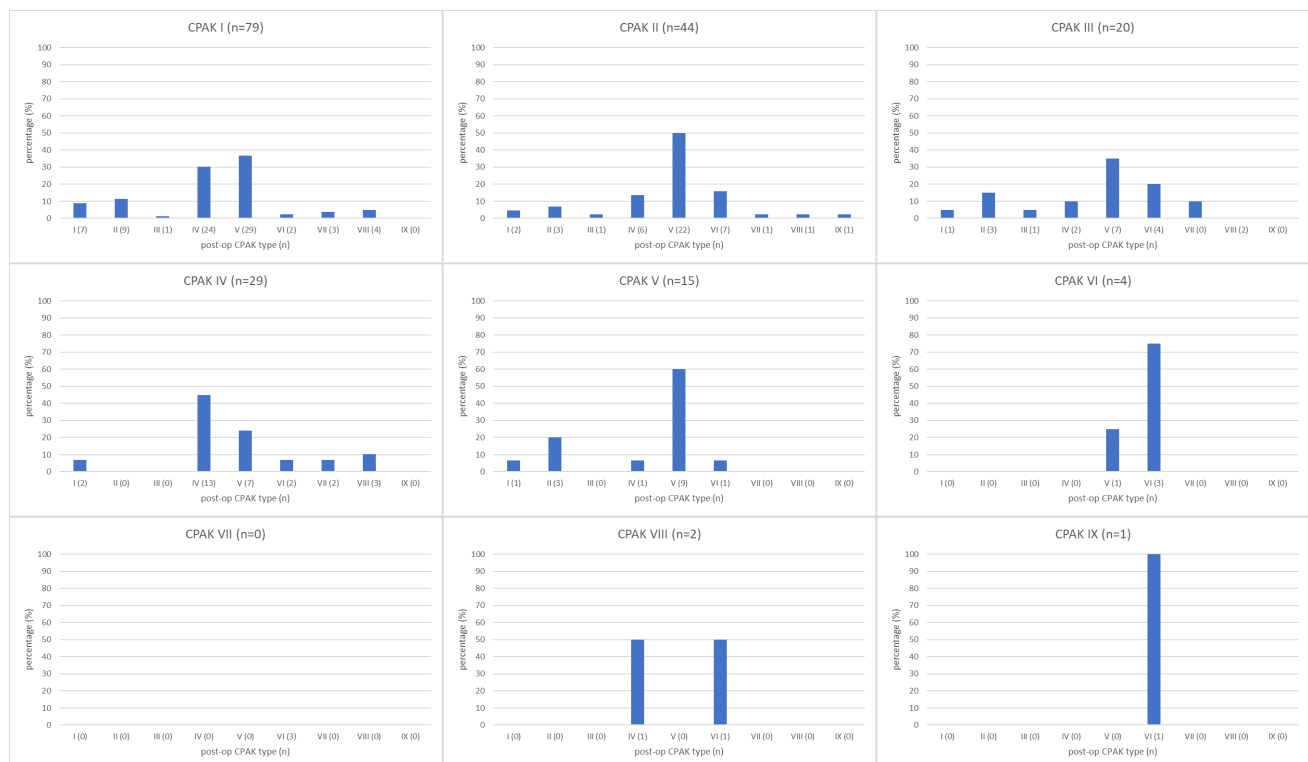


Figure 5 Postoperative CPAK Classification After MA TKA According to the Preoperative CPAK Classification

Table 2 Preoperative Radiographic Parameters According to CPAK Classification

	Mean LDFA ° (SD)	Mean MPTA ° (SD)	Mean JLO ° (SD)	Mean aHKA ° (SD)
CPAK I (n = 79)	89.39 (1.88)	83.95 (1.64)	173.34 (2.32)	−5.44 (2.67)
CPAK II (n = 44)	86.66 (1.40)	86.23 (1.12)	172.89 (2.30)	−0.44 (1.07)
CPAK III (n = 20)	83.64 (1.95)	88.87 (1.83)	172.51 (2.69)	5.23 (2.66)
CPAK IV (n = 29)	92.42 (2.45)	86.14 (1.78)	178.56 (1.53)	−6.27 (4.00)
CPAK V (n = 15)	89.39 (0.60)	89.33 (0.58)	178.72 (0.80)	−0.06 (0.86)
CPAK VI (n = 4)	87.68 (1.10)	91.63 (0.80)	179.31 (1.70)	3.96 (0.90)
CPAK VII (n = 0)	0	0	0	0
CPAK VIII (n = 2)	92.90 (0.21)	91.58 (0.67)	184.48 (0.46)	−1.33 (0.88)
CPAK IX (n = 1)	90.35 (n/a)	93.5 (n/a)	183.85 (n/a)	3.15 (n/a)

Abbreviations: SD, standard deviation; LDFA, lateral distal femoral angle; MPTA, medial proximal tibial angle; JLO, joint line obliquity; aHKA, arithmetic hip–knee–ankle; CPAK, coronal plane alignment of the knee

Table 3 Postoperative Radiographic Parameters According to CPAK Classification

	Mean LDFA ° (SD)	Mean MPTA ° (SD)	Mean JLO ° (SD)	Mean aHKA ° (SD)
CPAK I (n = 13)	89.96 (0.88)	85.19 (1.29)	175.15 (1.13)	−4.77 (1.90)
CPAK II (n = 18)	87.79 (0.88)	87.47 (1.13)	175.26 (1.80)	−0.32 (0.92)
CPAK III (n = 3)	86.63 (0.56)	89.67 (0.78)	176.30 (0.31)	3.03 (1.31)
CPAK IV (n = 48)	91.82 (1.28)	87.69 (1.24)	179.51 (1.82)	−4.13 (1.74)
CPAK V (n = 75)	89.87 (0.98)	89.76 (1.02)	179.63 (1.61)	−0.11 (1.19)
CPAK VI (n = 20)	88.62 (0.98)	91.8 (1.02)	180.42 (1.83)	3.18 (0.78)
CPAK VII (n = 6)	94.38 (1.64)	91.00 (1.68)	185.39 (3.22)	−3.38 (0.84)
CPAK VIII (n = 10)	92.61 (0.75)	91.94 (0.75)	184.55 (1.03)	−0.68 (1.09)
CPAK IX (n = 1)	90.3 (n/a)	92.85 (n/a)	183.15 (n/a)	2.55 (n/a)

Abbreviations: SD, standard deviation; LDFA, lateral distal femoral angle; MPTA, medial proximal tibial angle; JLO, joint line obliquity; aHKA, arithmetic hip–knee–ankle; CPAK, coronal plane alignment of the knee

including postoperative stiffness (n = 4), periprosthetic joint infection (n = 4), secondary patellar resurfacing (n = 3), anterior knee pain (n = 1), and intraoperative tibial fracture (n = 1). Conversely, one minor superficial wound complication (2.7%) was reported in the restored group.

DISCUSSION

In this study, 81.4% of knees in patients undergoing MA TKA exhibited postoperative alterations in the CPAK classification. Although conventional instrumentation aims to achieve CPAK type V (neutral aHKA and JLO), its inherent imprecision can result in unintended alignment outcomes, including non–type V phenotypes and, in some cases, incidental restoration of the preoperative

CPAK classification. In the present cohort, however, the rate of such restoration was low.

The observed rate of CPAK alteration was slightly higher than that reported by Corban et al., in which 75.3% of knees demonstrated a change in CPAK classification after MA TKA using conventional instrumentation.¹⁵ This discrepancy may reflect population-related differences. Their cohort comprised a non-Asian population, in which CPAK type V is more prevalent, whereas Asian populations tend to exhibit constitutional varus alignment. In the original study by Macdessi et al., CPAK type II was the most common phenotype (32.2%), while type V accounted for 14.6% in an arthritic population.¹⁰ In contrast, CPAK type I was the most prevalent in our cohort (40.7%), and only 7.7% of knees were classified as type V preoperatively. Similarly, a recent study of Thai patients with knee OA reported type I as the most common phenotype (49.3%), with a low prevalence of type V (6.5%).¹¹

Another possible explanation is that only 38.7% of knees in our study achieved CPAK type V postoperatively, which is the intended alignment target of MA TKA. This inaccuracy may be due to the limitations of conventional instrumentation, particularly when performing frontal cuts on the distal femur and proximal tibia, which can cause deviation from the intended neutral alignment.^{16,17}

Notably, this study demonstrates that knees with a preoperative neutral joint line (CPAK type IV, V, VI) were more likely to return to their original CPAK classification after MA TKA, consistent with the findings of Corban et al.¹⁵ In MA TKA, both LDFA and MPTA are typically targeted at 90°. However, the accuracy of coronal bone cuts using conventional instrumentation is generally within $\pm 3^\circ$ in most cases.¹⁸ Consequently, small variations in the relative difference between MPTA and LDFA can readily produce alignment within CPAK types IV, V, and VI. In contrast, larger and more directional deviations are required to shift alignment into other CPAK phenotypes, which may explain their lower probability of occurrence.

Although comparisons between preoperative and postoperative CPAK classifications showed that only a small proportion of knees in our cohort were restored to their original phenotype, no significant differences in ROM or WOMAC scores were observed between the restored and non-restored groups. These findings should be interpreted with caution, as the uneven distribution of cases, with a predominance of non-restored knees,

may have introduced bias.

A previous randomized controlled trial comparing 180 patients with restored and non-restored CPAK classification after TKA found no significant differences in any patient-reported outcomes (PROMs) between the two groups 1 year postoperatively. However, patients in the non-restored CPAK group tended to require more soft-tissue release.¹⁹ Similarly, in Bertugli et al.'s retrospective study involving 201 patients, no significant differences in PROMs after TKA were observed between patients with restored and non-restored CPAK classification. Additionally, they reported similar mean postoperative satisfaction levels between the two groups (4.4 ± 1.1 vs. 4.4 ± 1.0).²⁰ Conversely, Konishi et al. investigated the impact of alterations in the CPAK classification after TKA and reported that patients whose alignment shifted from varus to valgus and vice versa and who developed apex-proximal JLO postoperatively demonstrated poorer PROMs.⁸ Therefore, restoring CPAK classification may not be essential for achieving satisfactory outcomes, as long as mechanical stability and soft-tissue balance are maintained. However, further studies are needed to clarify the influence of alterations in the CPAK classification on long-term clinical outcomes.

This study has several limitations. First, the retrospective nature of this study may introduce an inherent selection bias and limits control over potential confounding factors that may affect the outcomes. However, all eligible patients were consecutively enrolled in this study to minimize this potential bias. Second, radiographic measurements were performed by a single observer. Although intraobserver reliability was good to excellent, this approach may introduce measurement bias and does not allow for the assessment of interobserver reliability. Third, a substantial proportion of patients had missing WOMAC data, representing an important limitation. Consequently, a complete-case analysis was performed, which may introduce selection bias and reduce statistical power. Fourth, no standardized protocol was used for clinical outcome assessment; therefore, data from the most recent follow-up were used, which may affect the comparability of outcomes. Finally, the follow-up duration was relatively short, which limits the ability to assess long-term outcomes. Further prospective studies with longer follow-up and rigorous methodologies are needed to investigate the significance of alterations in the CPAK classification after TKA.

CONCLUSION

A fixed MA TKA target may alter CPAK classification postoperatively, with only a limited proportion of patients restoring their original CPAK classification. However, no significant differences in clinical outcomes were observed between patients who restored their CPAK classification and those who did not.

Conflict of Interest

The authors declare no conflicts of interest related to the content of this article.

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The authors have no acknowledgments. Furthermore, the authors did not use artificial intelligence (AI) in the preparation of this manuscript.

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Supervision: I.O.

Validation: N.H., I.O.

Visualization: P.W.

Writing – original draft preparation: P.W.

Writing – review & editing: P.W., N.H., I.O.

Data availability statement

The datasets used and/or analyzed in this study are available from the corresponding author upon reasonable request.

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REVIEW ARTICLE

Effect of Lumbar Flexion on Prone Positioning of Patient for Endoscopic Lumbar Spine Surgery: Narrative Review

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ABSTRACT

Endoscopic spine surgery offers significant advantages over conventional techniques, but its success depends on careful attention to many intraoperative factors, particularly patient positioning. This review highlights the importance of understanding spinal anatomy and common variations, as well as the biomechanical effects of the positioning during surgery. Lumbar flexion increases posterior disc height and intradiscal pressure, enhancing disc bulging and widening the interlaminar window, which facilitates safer and more effective discectomy and decompression. These changes, especially over 20-40 degrees of flexion, also increase foraminal dimensions and surgical access, particularly in lower lumbar levels or cases with foraminal stenosis. Regarding positioning for endoscopic lumbar surgery, preoperative imaging and anatomical assessment are crucial to guide the approach and positioning strategy. Lumbar flexion of approximately 40 degrees is recommended for discectomy and decompression, as it improves access and reduces bone resection in both interlaminar and transforaminal approaches. In certain cases, especially central or foraminal pathology, intraoperative repositioning may be necessary to ensure complete decompression and prevent recurrence. Optimal patient positioning in endoscopic lumbar surgery enhances surgical access, ensures safety, and minimizes tissue trauma.

Keywords: endoscopy, lumbar, minimally invasive, morphology, positioning

INTRODUCTION

Endoscopic spine surgery (ESS) has gained widespread acceptance due to its minimal invasiveness, reduced postoperative pain, and faster recovery time compared to traditional open or microscopic spinal surgery techniques.^{1,2} Despite these advantages, the success of ESS relies on meticulous attention to multiple intraoperative factors, among them is the patient

positioning. There are various techniques and recommendations proposed, but no article dedicated to a comprehensive review on this issue.³ This narrative review aims to describe the surgical-related anatomy, effects of the patient positioning on the procedure based on the surgical approach in ESS, and our recommendations regarding the positioning to facilitate the endoscopic procedure.

CONTENT OF REVIEW

A literature search was conducted using PubMed to identify relevant articles examining the effects of prone patient positioning on anatomical structures associated with endoscopic lumbar spine surgery. The primary search included MeSH terms such as “spine”, “anatomy”, “lumbar”, “prone position”, “dimension”, “morphology”, and “minimally invasive.” Relevant and current literature was subsequently reviewed, and the reference lists of the retrieved articles were screened to identify additional pertinent studies.

Anatomy Relevant to Lumbar Surgery

Generally, lumbar surgery goals depend on the symptoms and pathology, including decompression of the neural elements or providing stability by instrumentation or fusion. Another important consideration is the alignment of the spine, which could greatly impact the surgical outcomes.⁴ To achieve these goals, especially by minimally invasive techniques such as endoscopic surgery, knowing the precise related anatomical structures is very crucial to safely and effectively completing the surgery.⁵ Equally important is awareness of common anatomical variations or anomalies, such as conjoined nerve roots or facet tropism, that can impact surgical strategies.

Bony Landmarks and Joints

The posterior spinal anatomy includes the laminae forming the roof of the spinal canal and the interlaminar space as a natural access corridor, bordered laterally by the facet joint capsule, which provides stability and should be preserved. The facet joints serve as key posterolateral landmarks of the spinal canal, with their orientation shifting from predominantly sagittal in the upper lumbar spine to more coronal at the L5-S1 level.⁶ This orientation of the facet emphasizes the importance of precise preoperative planning, which will influence the choice of surgical approach, as preservation of the facet joint is essential to maintain spinal stability during the procedure.⁷ Partial medial facetectomy exceeding 50-75% has been identified as a threshold beyond which vertebral segment instability significantly increases.^{8,9} Additionally, patients with degenerative spondylolisthesis exhibit more sagittal oriented facet joints and greater facet joint tropism than controls, underscoring the importance of individualized surgical planning.¹⁰

Anatomy Related to Interlaminar Approach

The ligamentum flavum, a paired elastic structure connecting adjacent laminae, forms the posterior boundary of the spinal canal and is encountered during lumbar discectomy. To access the dural sac and nerve roots, the ligament is typically detached from its attachment or incised under protection to expose the epidural space. In spinal stenosis, hypertrophy and infoldings of the ligamentum flavum contribute to neural compression, often requiring flavectomy or laminectomy for adequate decompression.¹¹

The posterior longitudinal ligament (PLL), situated along the back of the vertebral bodies, may be visualized beneath the neural elements. Large disc herniations can breach the PLL, may necessitate partial PLL resection and careful removal of sequestered fragments from beneath the ligament after disc space entry.¹²

In adults, the spinal cord ends at the L1-L2 level, transitioning to the cauda equina, so lumbar discectomy and decompression involve nerve roots rather than the spinal cord.¹³ During interlaminar surgery, the traversing nerve root and dural sac are identified and gently retracted to access the herniated disc or compressing structures, with careful inspection to ensure nerve decompression and avoid injury.

Anatomy Related to Transforaminal Approach

The intervertebral foramen serves as the passage for the exiting spinal nerve root. Consequently, foraminal or far lateral herniations more often involve the exiting nerve root at the corresponding level, whereas paracentral disc herniations typically compress the traversing nerve root. Within the foramen, the nerve root and dorsal root ganglion (DRG) are surrounded by epidural fat and vascular structures.¹⁴ Transforaminal ligaments, when present, are fibrous bands that can occupy up to 28.5% of the foraminal space and may compress the nerve root.¹⁵ Although their contribution to nerve entrapment remains debated, their presence necessitates careful surgical dissection.

In transforaminal endoscopic discectomy, the proximity of the exiting and traversing nerve roots, particularly the DRG, poses a risk of injury. Irritation of the DRG can result in postoperative dysesthesia radicular pain, known as “DRG syndrome”, with reported incidence rates ranging from 10-22%.^{16,17} A well understanding of the location of the DRG helps

the surgeon avoid direct compression during the surgery.

Common Anatomical Variations

A conjoined lumbosacral nerve root is a developmental anomaly where two adjacent roots exit through a single dural sleeve, most often involving L5 and S1, with an incidence of 0.25-1.3% in lumbar disc surgeries.^{18,19} This variant can obscure disc fragments or be mistaken for a single root, increasing the risk of inadequate decompression or nerve injury. Preoperative imaging may suggest the anomaly, but intraoperative recognition and careful foraminal decompression are essential to avoid complications.

Facet joint orientation and morphology vary among individuals and can influence surgical access. Facet tropism, or asymmetry between left and right facet angles at a given level, is common and may contribute to uneven loading and disc herniation.²⁰ Significant asymmetrical anomalies may necessitate adjustments in surgical technique, such as performing a wider laminotomy to access the recess. Furthermore, if the approach angle prevents facet joint preservation, an alternative approach may be required.²¹

Effects of the Patient Positioning

Interlaminar Lumbar Approach

Endoscopic interlaminar approach is one of the most used techniques for lumbar decompression

and discectomy. The approach is done through the space between the upper and lower lamina of the level of pathology. On the lateral margin are the pars interarticularis and the facet joint, while the medial side is the base of the spinous process (Figure 1). These structures are the frame which sometimes limit the access to the compressing pathology such as intervertebral disc or the ligamentum flavum in the lateral recess and central zone.²²

The size of the interlaminar window depends on the position of the patient. Luis et al. conducted a cadaveric study demonstrating that lumbar position, from neutral to flexion, has a great impact on the interlaminar window size.²³ Their study found that in neutral position, the interlaminar distance ranges from 12.21 to 14.88 mm, whereas in flexion ranges from 17.15 to 18.5 mm in young normal cadavers. In upper lumbar segment or severe lumbar spinal stenosis patients, with osteophytes and hypertrophic facets, the interlaminar space can be significantly narrowed, leaving limited access to perform decompression in the spinal canal. Further emphasizes the importance of positioning to aid in the endoscopic procedure.

Lumbar flexion directly affects the intervertebral disc by increasing posterior disc height, which can create additional space to aid in surgical procedures such as discectomy (Figure 2). The flexion position also raises intradiscal pressure, leads to an increase in posterior bulging of the disc,^{24,25} resembling to

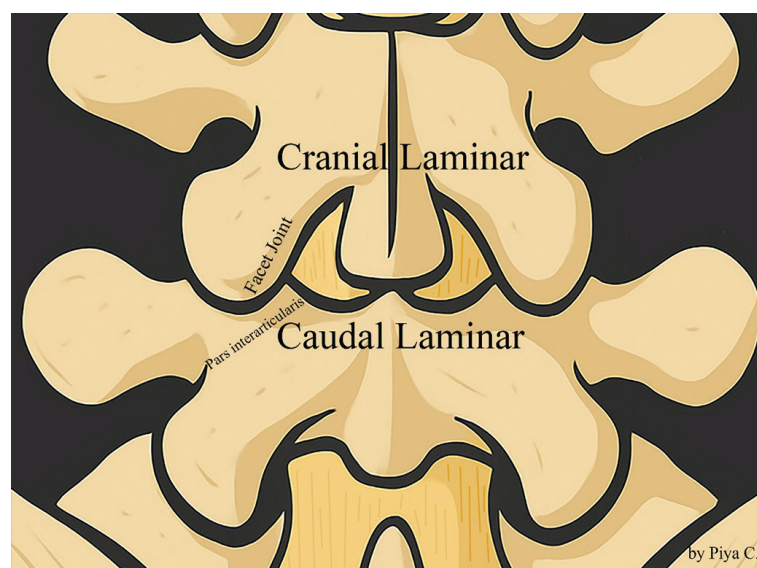


Figure 1 Structures Surrounding the Interlaminar Window in the Lumbar Vertebra

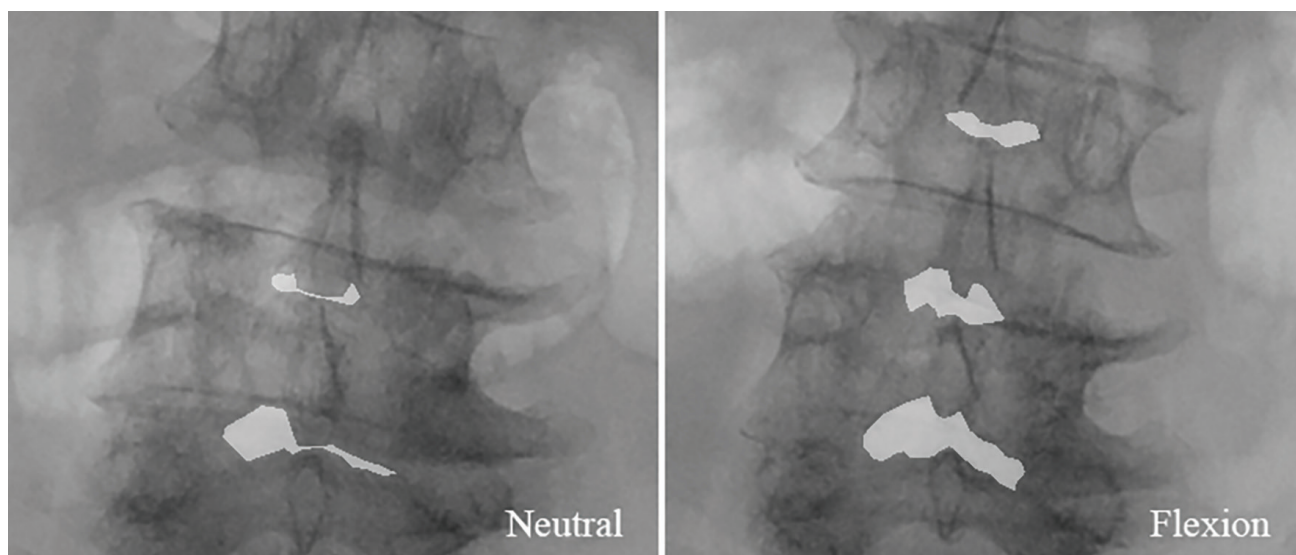


Figure 2 Fluoroscopic Images Comparing the Interlaminar Windows Size in Neutral and Flexion Position

levels observed during upright posture or routine activities, it may also facilitate the extrusion of residual disc fragments, potentially reducing the risk of recurrent disc herniation postoperatively.

Ligamentum flavum is the floor of the interlaminar space guarding the thecal sac and nerve roots. It attaches from the undersurface of the cranial lamina to the upper margin of the caudal lamina. In case of discectomy through this approach, surgeons must go through this layer to reach the herniated disc in the spinal canal. With the lumbar in flexion position, the ligamentum flavum is stretched thinner along the spreading interlaminar window, and with some tension, making it easier to cut or detach from the insertion.²⁶

Transforaminal Approach

In contrast to the interlaminar space, the foraminal height is decreased at the lower lumbar level. The foraminal size generally increased in flexion and decreased in extension, except at L5-S1. The changes were significantly correlated with lumbar angular motion, especially in more than 20 to 40 degrees, particularly affecting foraminal height and area at most levels and foraminal width at L3-4 and L4-5.^{27,28} (Figure 3). With increased posterior disc bulging in flexion position in combined with a wider approach corridor, enhances effective discectomy and safety by reducing the complications related to nerve root injury while approaching, especially in the lower lumbar level or cases with foraminal stenosis.²⁵

Author's Recommendation

Positioning patients for endoscopic lumbar surgery in a prone position, generally based on the goals of the surgery, with consideration to achieve the surgical goals effectively, ensuring the safety, and minimizing unnecessary tissue trauma from the procedure. According to previous literature, authors' recommendations are as follows.

Preoperative Planning

A thorough preoperative assessment, including imaging review and understanding patient-specific anatomical variations and pathology, is essential for determining the surgical approach and the optimal positioning.

Endoscopic Lumbar Discectomy

It is recommended that patients be positioned with approximately 40 degrees of lumbar flexion relative to full extension. This positioning can be accomplished by placing a bolster at the level of the iliac crests combined with surgical table adjustments (Figure 4) or by employing specially designed tables or positioning devices, such as the Wilson frame. This position maximizes the surgical corridor and reduces bone resection for adequate exposure, along with increasing intervertebral disc pressure and posterior bulging to allow effective discectomy. Generally, endoscopic working sleeves range from 7-10 mm in diameter. Therefore, even a few extra millimeters can significantly enhance the surgical procedure. Furthermore, in some patients, especially in central disc discectomy, may

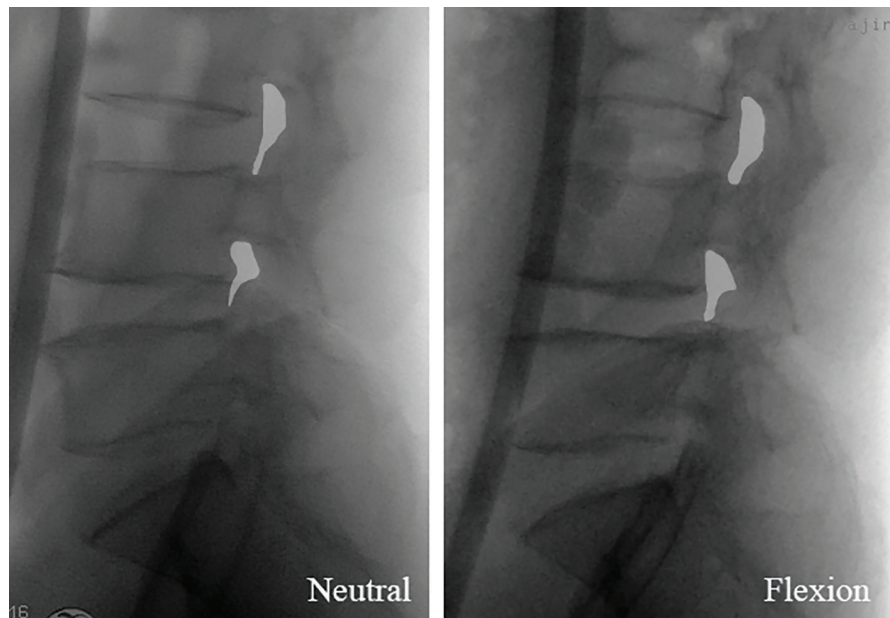


Figure 3 Fluoroscopic Images Comparing Foraminal Size in Neutral and Flexion Position



Figure 4 Lumbar flexion in the prone position can be achieved by placing a bolster under the iliac crests and adjusting the bend of the surgical table.

benefit from intraoperative repositioning by dynamically moving from flexion to neutral or slight extension to ensure no residual disc remains and reduce the risk of early recurrent herniation.

Endoscopic Lumbar Decompression

Most common compression zones are the lateral recess, central canal, and foraminal zone, which

mostly require access to the intracanalicular area and benefit from lumbar flexion positioning to minimize the required bone resection for the approach. However, in the lumbar flexion position, the foraminal zone compressed by the hypertrophic facet joints may be different from the normal physiological state, and the compression may be masked by positioning decompression. Therefore, in foraminal stenosis,

repositioning the patient intraoperatively after the foraminotomy to ensure the decompression is recommended.

However, as part of standard care, it is essential to reassess all pressure points after each adjustment of the patient's position. Particular attention should be given to the eyes, neck, chest, abdomen, and all areas in contact with the support surfaces to prevent complications related to positioning.^{29,30}

Limitation and Future Direction

This study has several limitations. First, it focuses specifically on the uniportal endoscopic decompression technique. However, the underlying principles described may also be applicable to other decompression surgical approaches, such as biportal endoscopic techniques or microscopic surgery. Second, this review focuses on positioning considerations for decompression surgery and does not address fusion or deformity correction procedures, in which spinal alignment plays a more critical role. Finally, the level of evidence supporting optimal positioning to enhance surgical effectiveness remains limited, as current data are largely derived from biomechanical and retrospective studies, with a lack of strong clinical evidence demonstrating clear clinical benefits. Future prospective clinical studies evaluating the impact of surgical positioning may help clarify its role and provide guidance for surgical practice.

CONCLUSION

In our literature review, patient positioning has been shown to influence various morphological structures of the lumbar spine, directly affect the endoscopic lumbar procedures. For most endoscopic lumbar decompression procedures, positioning the patient in approximately 40 degrees of lumbar flexion is recommended. However, tailoring positioning strategies to the specific underlying pathology or anatomical variations may improve surgical visualization, reduce complications, and enhance the overall safety and effectiveness of the procedure.

Conflict of Interests

Ali Guven Yorukoglu serves as a consultant for RIWOspine GmbH, Germany. The other authors have no conflicts of interest to declare.

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During the preparation of this work the author(s) used ChatGPT in order to improve readability and language. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Investigation: -

Methodology: P.C.

Project administration: P.C.

Resources: -

Software: -

Supervision: A.G.

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CASE REPORT

Metastatic Prostate Cancer Presented with Stauffer Syndrome-Like Paraneoplastic Cholestasis: A Case Report

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ABSTRACT

Prostate cancer is common cancer diagnosed in men, primarily affecting those older than 60 years. Bone metastasis, which is the most frequent metastatic site, significantly reduce survival time. We present the case of an 83-year-old Thai male diagnosed with advanced prostate cancer and bone marrow metastasis who developed jaundice. Laboratory results show anemia, thrombocytopenia, and unexplained cholestasis. Viral hepatitis and autoimmune hepatitis were excluded. Magnetic resonance imaging with magnetic resonance cholangiopancreatography showed no biliary obstruction. Bone marrow biopsy confirmed metastatic prostate cancer. Due to anemic symptoms and fatigue, only medical castration was chosen as first-line treatment. 2 months after treatment, the patient had significantly improved in anemia, thrombocytopenia, bilirubin level, prostate-specific antigen levels, and clinical status. The patient can well tolerate the treatment. This improvement is consistent with Stauffer syndrome-like; a paraneoplastic syndrome most often associated with renal cell carcinoma but rarely reported in prostate cancer.

Keywords: paraneoplastic syndrome, prostate cancer, Stauffer syndrome

INTRODUCTION

Prostate cancer is the most common cancer among men and the fourth most frequent cancer globally. predominantly diagnosed in men over 65, its clinical presentation ranges from indolent localized tumors to highly aggressive metastatic disease. Bone metastasis, especially to the axial skeleton, is a hallmark of advanced disease that significantly compromises quality of life and reduces overall survival.

Paraneoplastic syndromes are systemic disorders that occur before or during cancer diagnosis. Their symptoms are not directly related to the primary tumor

site but result from cancer-secreted hormones or cytokines that affect other organ systems. Stauffer syndrome first described in 1961 by Stauffer, is a rare paraneoplastic syndrome characterized by abnormal liver function tests without evidence of biliary obstruction from radiologic imaging and exclude other possible causes. Its hallmark is cholestatic jaundice, sometimes accompanied by hepatitis-like features. The syndrome is commonly associated with renal cell carcinoma, occurring in about 3–6% of patients.¹ Primary cancer treatment, regardless of disease staging, improve the symptoms.² However, the presence of Stauffer

syndrome is a negative prognostic factor.³ Although prostatic cancer with confirmed Stauffer syndrome has been reported rarely.^{4,5} Cholestasis without obstructive jaundice pattern is diagnostic hallmark. The proposed mechanism involves cytokine release, particularly interleukin-6 (IL-6), leading to cholestasis.⁶ From report, Pathological reports of liver biopsy show foci of bile stasis, with acute inflammation of the bile duct in the portal triad, and absent evidence of granulomatous inflammation or malignancy.⁷ For classical Stauffer syndrome, Latest proposed diagnostic criteria suggest liver biopsy may be necessary for definite diagnosis whereas no known liver pathological pathognomonic features.⁸ However, without liver pathology, Stauffer syndrome-like can diagnosed in the context of diagnosed malignancy other than renal cell carcinoma. Treatment of the underlying malignancy usually improves the syndrome.

CASE REPORT

An 83-year-old Thai male, retired government officer lived in rural area of Bangkok. He had history of well-controlled hypertension on amlodipine. He denied history of smoking, alcohol drinking or other over the counter medication used. He visited local government hospital with chief complaints of chronic neck pain with fatigue. His general physical examination was unremarkable but pale conjunctiva. He was initially diagnosed with cervical spondylosis. Blood tests revealed anemia, thrombocytopenia, and elevated liver enzymes with cholestatic pattern without recent baseline tests. Whole abdominal computer tomography was done and showed neither significant liver mass nor biliary system dilatation. Enlarged prostate gland was noted without other intra-abdominal mass or lymph node. Diffused heterogeneous background of visualized bony structure was also shown. Magnetic resonance imaging with Cholangiopancreatography was performed later and reported no evidence of biliary tract obstruction. He was referred to Charoenkrung Pracharak Hospital for further evaluation. Physical examination on first visit showed neither lymphadenopathy, hepatomegaly, splenomegaly nor sign of chronic liver disease. Digital rectal examinations showed hard consistency prostate.

Due to laboratory showing unexplained multilineage cytopenia, consultant hematologist performed bone marrow biopsy and revealed metastatic adenocarcinoma consistent with prostate origin. Described as cuboidal malignant cells with enlarged hyperchromatic nuclei

and clear cytoplasm, with depletion of myeloid, erythroid, and megakaryocytic lineages (Figure 1). Immunohistochemistry was positive for prostate-specific antigen (PSA) and alpha-methyl acyl-CoA racemase, pathological result confirms bone marrow metastasis from prostate adenocarcinoma (Figure 2). The initial PSA level was 6344 nanograms (ng)/milliliter (mL) (normal range 0–4 ng/mL).

Further evaluation of cholestasis causes, Gamma-glutamyl transferase (GGT) level was 514 unit (U)/liter (L) showed marked elevation, viral serology (negative for hepatitis A, B, C, and E), autoimmune markers (antinuclear antibody, antimitochondrial antibody, and smooth muscle antibody negative), and

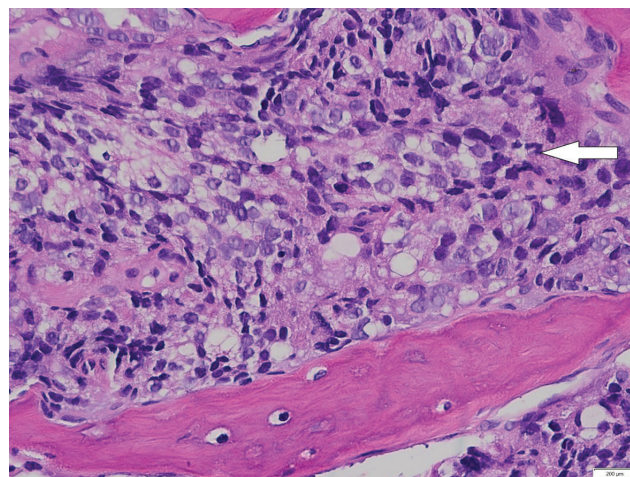


Figure 1 Bone Marrow Biopsy (H&E staining slide) Showed Metastatic Sheets of Malignant Cells Along Bone Marrow Cavity (scale bar = 200 μ m.)

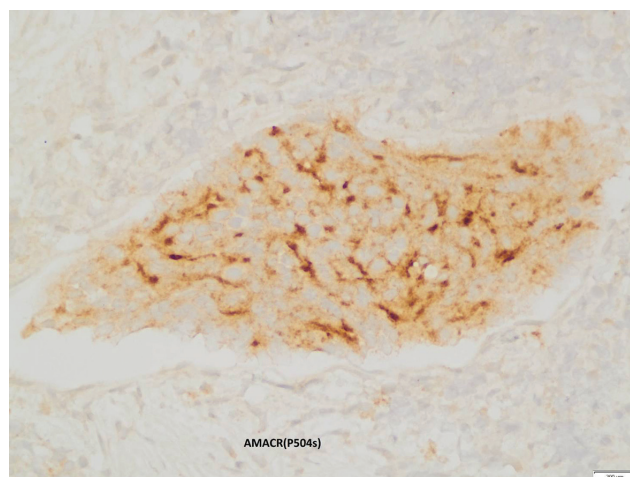


Figure 2 Alpha-Methyl Acyl CoA Racemase (AMACR) Showed Granular Cytoplasmic Staining of Malignant Prostatic Acinar Cells (scale bar = 200 μ m.)

magnetic resonance imaging with magnetic resonance cholangiopancreatography (**Figure 3**) showed neither biliary obstruction nor intraabdominal mass. Due to

severe thrombocytopenia risk for procedural bleeding tendency, liver biopsy and prostatic biopsy were deferred.

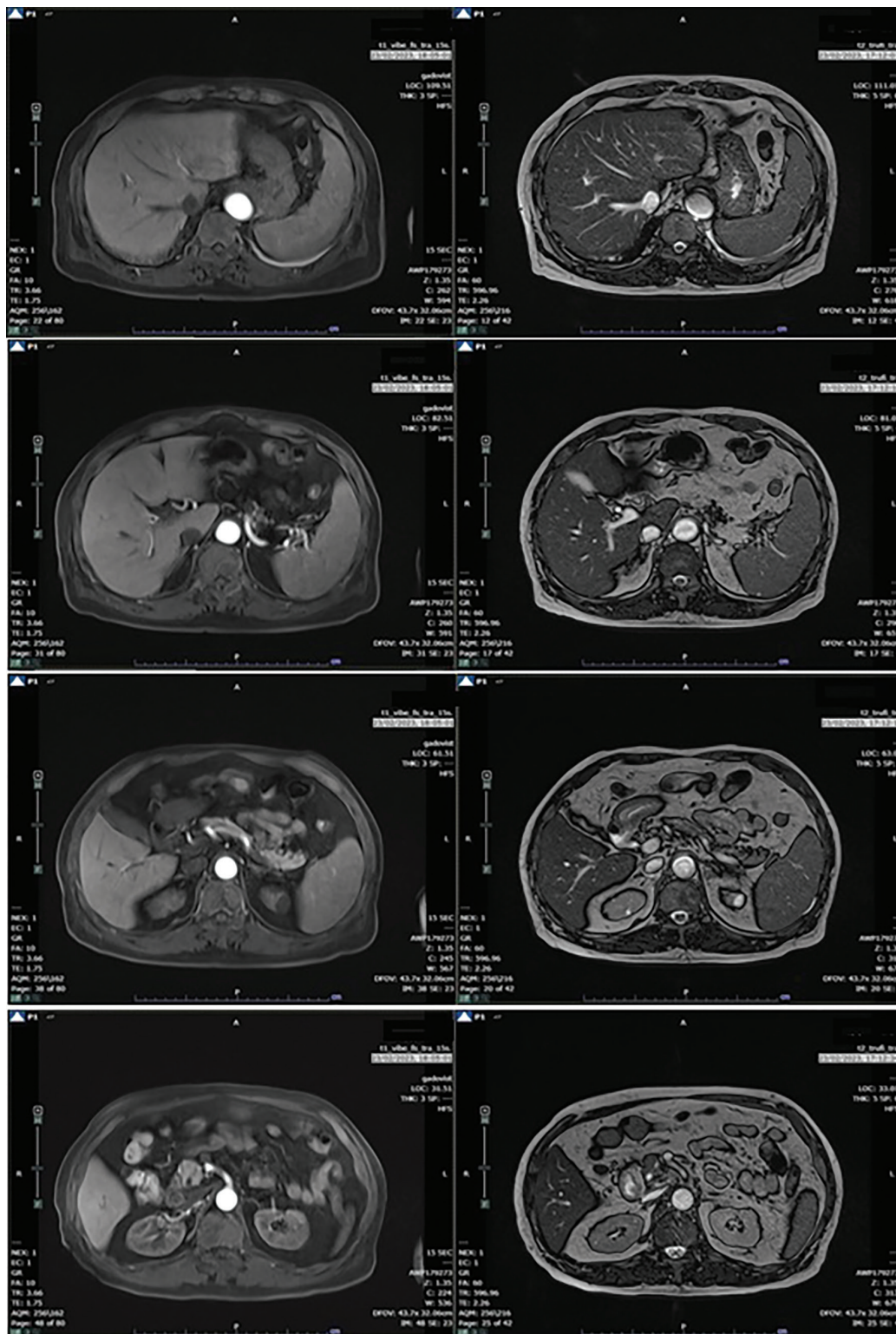


Figure 3 MRI Upper Abdomen with Gadolinium with MRCP in Axial T1 and T2 Showed Normal Size, Shape and Parenchymal Signal Intensity of Liver. Patent Portal Vein and Hepatic Veins. No Significant Evidence of Biliary Tract Obstruction on This Study.

The patient was diagnosed with advanced metastatic prostate cancer with paraneoplastic Stauffer syndrome. His Eastern Cooperative Oncology Group (ECOG) performance status was 2. Initial treatment with leuporelin acetate 11.25 mg intramuscular alone was started (baseline = T0), anti-androgen was not prescribed concurrently due to concerned about fatigue and abnormal liver function test. Zoledronic acid was started soon after dental examination.

Due to severe anemia, the following up appointment was made every 2 weeks for symptoms evaluation (T+2 weeks, T+4 weeks, T+6 weeks). He complained only about his fatigue as previously without either bleeding or other pain. His complete blood count showed same level of hemoglobin and thrombocytopenia. Two pack red blood cells were transfused to alleviate symptoms in every visit. Total bilirubin level was improved whereas alkaline phosphatase was rising instead. GGT level showed 326 U/L. This paradoxical change resulted from flared up of alkaline phosphatase (ALP) which typically occur within 1 month after treatment started.

At T+2 months, his anemia, thrombocytopenia, and cholestatic jaundice improved significantly. PSA dramatically decreased (Table 1). Testosterone level was still at the castration level and leuporelin acetate was prescribed every 12 weeks interval. ALP level started to decrease after flared up episode.

At T+7 months, Platelet counts reached normal level. PSA level was 7 ng/mL (nadir level). Bilateral orchiectomy was performed and had no complication. At T+13 months, PSA level continues rising for 2 consecutive times with 4 weeks apart above the nadir level (7 → 15 → 23 ng/mL). Confirmed testosterone level was still in castrated level. The patient's ECOG was 1 without any disturbance symptoms. He denied further imaging from personal reasons. Castration resistance prostate cancer was diagnosed and abiraterone with prednisolone was started. PSA level was stabilized for 8 months. Thereafter PSA level continued to rise again. Only oral medication was chosen by patient's decision to control disease.

DISCUSSION

Abnormal liver function in cancer patients requires careful evaluation to distinguish between biliary tract obstruction from liver metastasis, viral hepatitis,

drug-induced liver injury, sepsis-associated cholestasis, and paraneoplastic syndromes. In this case, liver dysfunction was presented before the diagnosis of prostate cancer. Imaging and laboratory studies excluded mainly biliary tract obstruction and other causes. The patient's cholestasis consistent with Stauffer syndrome-like after primary prostate cancer was diagnosed and treated.

Stauffer syndrome is a paraneoplastic liver dysfunction usually seen in renal cell carcinoma but rarely described as prostate cancer. The pathogenesis presumed from cytokine release, particularly IL-6.⁶ Treatment of the underlying malignancy typically leads to improvement. Histopathology of liver biopsy shows intrahepatic cholestasis with bile stasis and portal inflammation, but biopsy was not performed in this patient due to thrombocytopenia.

The specific management focused on palliative aim treatment. Although from imaging, CT scan shows diffuse bone lesion and marked elevated initial PSA level was compatible with high-risk patient. According to the LATITUDE trial,⁹ addition of abiraterone to androgen deprivation therapy (ADT) in high-risk metastatic prostate cancer significantly improves overall survival (53.3 vs. 36.5 months). Another alternative treatment is adding docetaxel to ADT from GETUG-AFU 15 trial, CHAARTED trial, STAMPEDE trial docetaxel arm.¹⁰⁻¹² The result mostly shows survival benefit except for GETUG-AFU only showed progression free survival. In this patient, only medical castration with leuporelin acetate was chosen due to modest tolerability and patient's coverage scheme.

CONCLUSION

Stauffer syndrome is a rare paraneoplastic manifestation of prostate cancer, characterized by cholestatic jaundice without biliary obstruction. Definite Diagnosis requires exclusion of liver metastasis, viral hepatitis, autoimmune, and other obstructive causes and monitor response after cancer treatment. Although no liver biopsy was yielded to confirm diagnosis, effectively control of tumor with ADT was associated with significant reversal hematologic and hepatic abnormalities, this highlights specific manifestation of paraneoplastic Stauffer syndrome-like in prostate cancer patients presented with unexplained liver dysfunction.

Table 1 Baseline and Follow Up Laboratory Investigation after Initiate Treatment

	Normal Range	*	T0 **	T+2w	T+4w	T+6w	T+2m	T+3m	T+4m	T+6m	T+13m
Hemoglobin	14-17.4 g/dL	9.2	5.8	6.5	6.9	5.7	9.1	10.3	12.3	12.0	12.3
Hematocrit	42-52%	27.3	17.2	19.4	21	17.5	28.5	32.6	36.4	35.6	35.5
Platelet	140-400x 10 ⁹ /L	74	50	50	68	82	126	124	163	165	182
SGOT	0-40 U/L	41	53	52	87	60	71	44	38	34	29
SGPT	0-41 U/L	23	33	39	98	71	94	71	55	59	37
ALP	40-129 U/L	899	681	644	3673	5930	3714	2192	919	391	135
Total Bilirubin	0-1.2 mg/dL	18.3	9.0	5.3	2.7	1.6	0.8	0.5	0.4	0.5	0.4
Direct Bilirubin	0-0.2 mg/dL	9.92	9.0	5.1	2.7	1.2	0.7	0.3	0.5	0.3	0.2
PT/INR	10-13 sec/0.8-1.2		12.9/1.12					12.4/1.05			
GGT	15-85 U/L	271	514		326						
PSA	0-4 ng/mL		6344	4576	2224	791	155	40	18	7	23
Management	Supportive		LPRC	LPRC	LPRC	LPRC					
	ADT		Leuprorelin Acetate (1 st dose 7/4/2566)								Orchiectomy

Abbreviations: ADT, androgen deprivation therapy; ALP, alkaline phosphatase; dL, deciliter; g, grams; GGT, gamma-glutamyl transferase; INR, international normalized ratio; L, liter; LPRC, leuprorelin; m, month; mg, milligrams; mL, milliliter; ng, nanograms; PSA, prostate-specific antigen; PT, prothrombin time; sec, second; SGOT, serum glutamic oxaloacetic transaminase; SGPT, serum glutamic pyruvic transaminase; T, time; U, units; w, week

* Investigation from refer out hospital, ** Baseline Investigation in Charoenkrung Pracharak Hospital

Conflict of Interest

The authors declare no conflicts of interest regarding this manuscript.

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Editor-in-Chief,

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In order to maintain the high standards of Journal of Medicine and Urban Health, our editorial team relies on the expertise of numerous professionals. They play a pivotal role in determining the topics to explore, deciding which manuscripts to publish, and making necessary adjustments to ensure the scientific integrity and reliability of the information provided. This fosters the growth and advancement of medical and health science research. I deeply appreciate the dedication and proficiency exhibited by the individuals who reviewed manuscripts for the journal from September 1st, 2025, through August 31st, 2026.

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