Dissertation

The Implementation of a Multimodal Concept in the Treatment of Orthopaedic and Traumatological Patients

submitted by

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Submitted in 2024

Declaration

I hereby declare that this thesis is my own original work and that I have fully acknowledged by name all of those individuals and organisations that have contributed to the research for this thesis. Due acknowledgement has been made in the text to all other material used. Throughout this thesis and in all related publications I followed the “Guidelines of the Medical University of Graz on Good Scientific Practice”.

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Disclosures

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Foreword

In the realm of medical practice, effective communication between doctors and patients stands as an essential cornerstone. The journey of this dissertation embarks on unraveling the intricate dynamics underlying this communication paradigm and its profound impact on therapy satisfaction. Through meticulous investigation, we navigate through the labyrinth of doctor-patient interactions, aiming to illuminate pathways toward heightened satisfaction and improved therapeutic outcomes.

Within the vast landscape of medical advancements, this dissertation unveils significant breakthroughs in the realm of local dexmedetomidine infiltration (LIA) during total knee arthroplasty (TKA). Our exploration reveals the transformative potential of LIA, synergizing with local anesthetics in ultrasound-guided regional anesthesia (USRA) to alleviate patient pain and reduce opioid dependency. The profound implications of this discovery extend far beyond conventional pain management, beckoning further inquiry into optimal medication dosages and adjuvant treatments.

Amidst the tapestry of findings, we uncover nuanced dynamics between LIA and USRA beneficiaries, shedding light on the multifaceted interplay of pain perception, well-being, and functional outcomes. Though LIA patients may experience transiently heightened pain levels, their journey towards rapid healing and rehabilitation is propelled by enhanced well-being—a testament to the intricate interplay of short-term discomfort and long-term recovery.

Furthermore, our exploration delves into the intricate realm of preoperative patient evaluation, particularly in the context of neuropathic pain. Through meticulous examination, we illuminate the pivotal role of neuropathic pain and psychological distress indicators, such as yellow flags, in shaping postoperative outcomes. This revelation underscores the imperative for tailored therapeutic approaches and the refinement of prognostic markers, paving the way for optimized patient selection and maximized benefits of TKA.

As we embark on this odyssey of discovery, I extend my heartfelt gratitude to all those who have contributed to this endeavor. May the insights gleaned from this dissertation serve as guiding beacons, illuminating pathways toward enhanced doctor-patient relationships, optimized pain management strategies, and ultimately, improved patient outcomes.

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Abbreviations and Definitions

16-NCC	Need for Cognitive Closure Scale
AAQ-II	Acceptance and Action Questionnaire II
ANP	Anaesthesiology Follow-up Questionnaire
BMI	Body Mass Index
CAT	Computerised Adaptive Test
CPSP	Chronic Postsurgical Pain
DN4	Douleur Neuropathique en 4 Questions
EVANLR	Evaluation du Vécu de l'Anesthésie Loco Régionale
FJS	Forgotten Joint Score
FNB	Femoral Nerve Block
FSQ	Fibromyalgia Survey Questionnaire
GAD	General Anxiety Disorder
HADS	Hospital Anxiety and Depression Scale
IASP	International Association for the Study of Pain
IOA	Intolerance of Ambiguity Scale
IQR	Interquartile Range
IUS-12	Intolerance of Uncertainty Scale
KSFS	Knee Society Function Score
KSKS	Knee Society Knee Score
LIA	Local Infiltration Anaesthesia
LOS	Length of Stay
NOPA	Non-Opioid Analgesics
NRS	Numeric Rating Scale
OKS	Oxford Knee Score
OME	Oral Morphine Equivalents
OPD	Outpatient Department
ORIF	Open Reduction Internal Fixation
PACU	Post Anaesthesia Care Unit
PCS	Pain Catastrophizing Scale
PROMIS	Patient-Reported Outcomes Measurement Information System
ROM	Range of Motion

SD	Standard Deviation
SF-36	Short Form 36
SNB	Sciatic Nerve Block
THA	Total Hip Arthroplasty
TKA	Total Knee Arthroplasty
TRPA	Transient Receptor Potential Ankyrin
TRPV	Transient Receptor Potential Channels
TSA	Total Shoulder Arthroplasty
UCC	Urgent Care Centre
USRA	Ultrasound-Guided Regional Anaesthesia
VUCA	Volatility, Uncertainty, Complexity and Ambiguity
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index

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Abstract in German

Einleitung:

Das österreichische Gesundheitssystem hat mit der steigenden Zahl orthopädischer und traumatologischer Erkrankungen zu kämpfen, die die Lebensqualität und das tägliche Funktionieren der Patienten beeinträchtigen. Angesichts der Komplexität des Körpers können herkömmliche Einzelbehandlungen nicht ausreichen, um eine umfassende Genesung zu gewährleisten. In dieser Dissertation wird ein multimodaler Behandlungsansatz für diese Patienten untersucht und die Hypothese aufgestellt, dass er zu einer Verbesserung der Ergebnisse und der Zufriedenheit der Patienten beiträgt. Der Schwerpunkt liegt dabei auf der analgetischen Medikation, wobei die praktische Umsetzung und die Wirksamkeit in verschiedenen klinischen Kontexten bewertet werden. Die Studie unterstreicht die Bedeutung einer multimodalen Behandlung und eines soliden Schmerzmanagements in der Orthopädie und Traumatologie und plädiert für eine breite Anwendung in der klinischen Praxis.

Methoden:

Wir führten eine prospektive Querschnittsbeobachtung in der Abteilung für Orthopädie und Traumatologie des Universitätskrankenhauses durch, die die orthopädische Spezialambulanz und Notaufnahme umfasste. Verschiedene Fragebögen bewerteten die Faktoren Volatilität, Ungewissheit, Komplexität und Mehrdeutigkeit (VUCA). In Umfragen nach der Konsultation wurden die Patientenzufriedenheit und die Wahrnehmung von VUCA-Lösungen bewertet. Eine andere Studie untersuchte die Wirksamkeit der lokalen bzw. regionalen Dexmedetomidin-Gabe bei Patienten, die sich einer Knietotalendoprothese (KTEP) unterziehen. Die Patienten wurden nach dem Zufallsprinzip entweder einer lokalen Infiltrationsanästhesie (LIA) oder einer ultraschallgesteuerten Nervenblockade (USRA) zugewiesen, um einen möglichen Unterschied der Wirkung zwischen der Wirksamkeit einer LIA und einer USRA zu eruieren. Der postoperative Opioidverbrauch, Schmerzwerte und Komplikationen wurden überwacht. Die Nachuntersuchungen wurden über einen Zeitraum von zwei Jahren durchgeführt. Darüber hinaus umfasste die Bewertung der neuropathischen Schmerzen verschiedene Fragebögen und Untersuchungen sowie die Erhebung demografischer und behandlungsspezifischer Daten.

Ergebnisse:

Diese Querschnittsbeobachtungsstudie untersuchte orthopädische Patienten in einem Universitätskrankenhaus und konzentrierte sich auf demografische Daten, Schmerzen und VUCA-Faktoren. Die Patienten, die die Notaufnahme aufsuchten, waren jünger und wiesen eine höhere Traumarate auf, während die Patienten in der orthopädischen Spezialambulanz älter waren und mehr nicht-traumatische Verletzungen aufwiesen. Die Schmerzintensität war in beiden Abteilungen ähnlich, aber die körperliche Funktion war in der Spezialambulanz besser. Die Patienten in der Spezialambulanz berichteten über mehr Unbeständigkeit, Unsicherheit und Unklarheit. Postinterventionelle Umfragen ergaben keine signifikanten Unterschiede in der Zufriedenheit zwischen den Abteilungen. Bezüglich der Zufriedenheit mit dem Arzt-Patienten-Gespräch hinsichtlich der VUCA-Faktoren der Volatilität, des Verstehens, der Klarheit und Adaptabilität konnte kein Unterschied zwischen der Notaufnahme und der Spezialambulanz gefunden werden. Darüber hinaus wurde in einer Studie zur Bewertung der lokalen Dexmedetomidin-Infiltration bei Patienten mit Knietotalendoprothese ein höherer Opioid Verbrauch in der Infiltrationsgruppe festgestellt, wobei keine unerwünschten Wirkungen beobachtet wurden. Die Bewertung neuropathischer Schmerzen ergab signifikante Unterschiede zwischen Hochrisiko- und Niedrigrisikogruppen nach der Operation, wobei sich die Schmerzwerte in beiden Gruppen im Laufe der Zeit verbesserten.

Ein Follow-Up nach 6 Wochen nach der lokalen Dexmedetomidin-Infiltration konnte einen signifikanten Vorteil für die Gruppe mit lokaler Infiltration (LIA) gegenüber jener mit ultraschallgesteuerter Regionalanästhesie behandelter Patient*innen zeigen.

Zusammenfassung:

Diese Studie wirft ein Licht auf die Verbesserung der Kommunikation zwischen Arzt und Patient, die zu einer höheren Therapiezufriedenheit führt. Es wurden signifikante Fortschritte bei der lokalen Dexmedetomidin-Infiltration (LIA) während einer Knietotalendoprothese (TKA) festgestellt, die im Vergleich zur ultraschallgesteuerten Regionalanästhesie (USRA) geringere Patientenschmerzen und einen geringeren Opioidverbrauch zeigte. Nachuntersuchungen ergaben eine nuancierte Dynamik, wobei LIA-Patienten zwar stärkere Schmerzen, aber ein besseres Wohlbefinden und ähnliche postoperative funktionelle Ergebnisse aufwiesen. Die präoperative Beurteilung neuropathischer Schmerzen erwies sich als entscheidend und hatte Auswirkungen auf die Ergebnisse der TKA, was die Notwendigkeit maßgeschneiderter Behandlungen und weiterer Forschung zur Optimierung der Kriterien für die Patientenauswahl unterstreicht.

Abstract in English

Introduction:

Austria's healthcare system grapples with the rising incidence of orthopaedic and traumatological conditions, impacting patient quality of life and daily functioning. Recognizing the body's complexity, traditional single treatments may fall short in ensuring comprehensive recovery. This dissertation explores a multimodal treatment approach for these patients, hypothesizing its efficacy in improving outcomes and satisfaction. Emphasizing analgesic medication, it evaluates practical implementation and effectiveness across various clinical contexts. The study underscores the importance of multimodal treatment and robust pain management in orthopaedics and traumatology, advocating for its widespread adoption in clinical practice.

Methods:

We conducted prospective cross-sectional observational research in the University Hospital's orthopaedics and traumatology department, encompassing the Urgent Care Centre (UCC) and the outpatient department (OPD). Pain intensity and physical function were assessed using the National Rating Scale for Pain (NRS) and Patient-Reported Outcomes Measurement Information System (PROMIS). Various questionnaires evaluated Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) factors. Post-consultation surveys evaluated patient satisfaction and perception of VUCA solutions. Another study evaluated the effectiveness of local and regional dexmedetomidine infiltration in patients undergoing total knee arthroplasty (TKA). Patients were randomly allocated to receive either local infiltration anaesthesia (LIA) or ultrasound-guided nerve blocks (USRA), to show an eventual difference between these two methods. Postoperative opioid consumption, pain scores, and complications were monitored. Follow-up assessments were conducted over a two-year period. Additionally, neuropathic pain assessment involved various questionnaires and examinations, alongside demographic and treatment-specific data collection.

Results:

This cross-sectional observational study investigated orthopaedic patients at a university hospital, focusing on demographics, pain, and VUCA factors. Patients visiting the Urgent Care Centre (UCC) were younger with a higher trauma rate, while those at the Outpatient Department (OPD) were older with more non-traumatic injuries. Patients at the OPD reported higher volatility, uncertainty, and ambiguity. Post-interventional surveys showed no significant differences in satisfaction between departments. For the patient's satisfaction in doctor-patient consultation regarding the VUCA-factors of volability, understanding, clarity and adaptability no difference between the UCC and OPD was shown. Additionally, a study evaluating local dexmedetomidine infiltration in knee arthroplasty patients found higher opioid consumption in the infiltration group, with no adverse effects observed. Neuropathic pain assessment revealed significant differences between high-risk and low-risk groups postoperatively, with improvements in pain scores over time for both groups.
A follow-up 6 weeks after the infiltration of dexmedetomidine revealed, that significant more patients in the group of local infiltration reported wellbeing, than in the group threated with ultrasound-guided regional anaesthesia.

Conclusion:

This study sheds light on enhancing doctor-patient communication, leading to increased therapy satisfaction. Significant advancements in local dexmedetomidine infiltration (LIA) during total knee arthroplasty (TKA) were revealed, showing reduced patient pain and opioid consumption compared to ultrasound-guided regional anaesthesia (USRA). Follow-up examinations uncovered nuanced dynamics, with LIA patients experiencing higher pain but improved well-being and similar functional outcomes postoperatively. Preoperative neuropathic pain assessment proved crucial, impacting TKA outcomes, underscoring the need for tailored treatments and further research to optimize patient selection criteria.

1. Introduction

Austria's healthcare system currently faces the challenge of treating a growing number of patients with orthopaedic and traumatological conditions. These conditions can significantly impair patient quality of life and their ability to perform daily activities. The human body is a complex system comprising numerous interacting elements. When treating orthopaedic and traumatological conditions, it is important to take this complexity into account. However, a traditional single treatment often cannot provide the support necessary to ensure full recovery and long-term health. A multimodal approach that combines different treatments is a promising way to provide holistic and effective therapy. This dissertation examines the implementation of a multimodal treatment concept for orthopaedic and traumatological patients. I hypothesise that the implementation of a multimodal treatment is effective for improving the treatment outcomes of orthopaedic and traumatological patients and improving patient satisfaction. This thesis examines the various approaches to multimodal treatment, with an emphasis on analgesic medication, and evaluates their practical implementation in clinical practice. It explores how the concept can be applied in different clinical contexts to maximise its effectiveness. This dissertation contributes to the understanding of the importance of multimodal treatment, as well as of sufficient pain management in orthopaedics and traumatology, and to promoting its implementation in clinical practice.

The introduction provides an overview of why patients visit outpatient clinics and why appropriate communication with the physician is essential. Furthermore, the current pain scheme used by the ward featured in this study and beyond is discussed.

The last section outlines the pain management of total knee arthroplasty to illustrate why almost all pain can be managed if the pain of total knee arthroplasty is also managed.

The studies on Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) factors, local dexmedetomidine infiltration, and patient satisfaction in total knee arthroplasty (TKA) play vital roles in shaping a comprehensive multimodal treatment approach for orthopedic and traumatological patients.

Firstly, the VUCA model, initially developed for military leaders, offers a valuable framework for healthcare professionals to navigate the unpredictable and complex

environments they encounter. By integrating the VUCA model into physician-patient communication, the studies hypothesize a significant enhancement in patient satisfaction during consultations. This approach acknowledges the multifaceted nature of patient care, emphasizing the need for adaptable communication strategies to address patients' anxieties and uncertainties effectively.

Secondly, the investigation into local dexmedetomidine infiltration as part of multimodal pain therapy for TKA highlights the importance of optimizing postoperative pain management. By targeting different pain pathways and reducing opioid consumption, this approach not only enhances patient comfort and speeds up recovery but also minimizes the risk of adverse effects associated with traditional pain management strategies. The study's findings underscore the benefits of utilizing adjunctive therapies like dexmedetomidine to improve the efficacy of local anesthesia and prolong postoperative analgesia.

Lastly, the exploration of patient satisfaction following TKA delves into the complex interplay between preoperative expectations, postoperative outcomes, and psychosocial factors. By identifying influential variables such as preoperative functional status, expectations, and concurrent disorders, the study provides insights into optimizing patient care and enhancing postoperative satisfaction. Understanding these factors is crucial for tailoring preoperative counseling, optimizing perioperative care, and implementing personalized interventions to maximize patient outcomes and satisfaction.

In summary, these studies contribute essential insights into the development of a multimodal treatment approach for orthopedic and traumatological patients. By addressing the dynamic challenges posed by VUCA environments, optimizing pain management strategies, and understanding the intricacies of patient satisfaction, healthcare professionals can deliver more comprehensive and patient-centered care, ultimately improving outcomes and enhancing patient experiences.

1.1 Pain

To assist understanding of this dissertation, this subsection provides an introduction to the concept of pain.

In 1979, the International Association for the Study of Pain (IASP) defined pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage”, which remains the established definition (4).

Pain is a subjective sensation that requires acknowledgment and assessment. Nociception (1.1.1.1) is different from the neurological process that utilises the pain pathway to transmit damaging messages to the brain. Pain arises from intricate connections among signalling systems, regulation of brain areas and individual perception. According to evolutionary theory, it serves as a protective mechanism by alerting the body to potentially hazardous physiological interactions and reactions during sickness (5).

The development of pain can be explained as a protective mechanism, alerting the recipient to possible detrimental responses. Unlike end-of-life pain, evolution cannot assist in the healing process after trauma, sickness or surgery. In this scenario, the pain is not beneficial and instead the hazardous physiological interactions progress to a distinct illness (6).

Regarding pain as a uniform phenomenon oversimplifies several intricate neurobiological and pathological relationships.

1.1.1 Categorisation of pain

Pain may be categorised systematically according to its duration or cause. Pain is often classified as acute or chronic according to its length. The difference between these two types is usually defined broadly, with most academics setting the threshold for chronic pain at 3, 6 or 12 months after its onset (7). Chronic pain is long-term pain. The source of the pain may be categorised into three specific types: nociceptive pain, nociplastic pain and neuropathic pain. Although these types may have similar clinical symptoms, their underlying causes are fundamentally different, and therefore they require unique treatment methods. These three types of pain are described in more detail in the following.

1.1.1.1 Nociceptive pain

Nociceptors are specialised sensory neurons in the peripheral nervous system that sense severe pressure, temperature changes and injury-causing substances to alert the body to impending danger. These neurons convert these impulses into electrical signals, which are subsequently sent to higher brain centres (8). They are found in almost all tissues, with the greatest concentration in the skin, although they are not present in the brain and organ parenchyma. Pain nociceptors are subcategorised into two primary types: monomodal receptors, which include mechanoreceptors and thermoreceptors, and polymodal receptors. Mechanoreceptors detect mechanical changes, causing an increase in the concentration of positively charged ions such as Na^+, K^+ and Ca^{2+} entering the nerve fibres. Additionally, these receptors frequently have transient receptor potential channels, which are susceptible to chemical stimuli such as capsaicin or elevated proton levels during acidosis, as well as extreme heat (typically over 42 °C) (9).

Temperature-sensitive nociceptors contain transient receptor potential vanilloid channels, which detect harmful heat stimuli. They also have transient receptor potential ankyrin 1 channels, which can be activated at low temperatures of less than 5 °C or by adding menthol (9). Polymodal nociceptors are mostly activated by chemical signals that reach certain receptors. They can also respond to mechanical and thermal signals at temperatures of 15 to 42 °C.

Monomodal and polymodal receptors differ not just in their sensitivity but also in how they transmit stimuli. Monomodal receptors are connected to fast-conducting Ad-fibres (with stimuli transmitted ab about 15 m/s), leading to the rapid and precisely located sensation of pain when activated. Afferents connected to polymodal nociceptors are made up of slowly conducting C-fibres, with stimuli travelling at around 1 m/s, resulting in a delayed and less accurately localised experience of pain (9).

1.1.1.2 Nociplastic pain

Nociplastic pain, a distinct type of pain recently recognized in medical literature, presents a challenge in diagnosis due to its similarity to central sensitization, with pathophysiology yet to be fully elucidated concerning alterations in spinal fluid

elements, brain white and gray matter structure, and psychological factors (10). The exact processes involved in nociplastic pain are not fully understood. However, current knowledge indicates that increased pain and sensory processing in the central nervous system (CNS), along with changes in pain modulation, are crucial factors in its emergence. Nociplastic pain is defined by indications of heightened or more widespread pain than expected from the known nerve or tissue injury. Moreover, patients may also exhibit additional CNS-related symptoms such as exhaustion, memory problems, sleep disruption and mood disorders. This pain can appear on its own, as observed in disorders such as tension-type headaches and fibromyalgia. It can also exist in combination with persistent neuropathic or nociceptive pain in mixed pain states, as observed in cases of chronic lower-back pain (11).

1.1.1.3 Neuropathic Pain

Neuropathic pain is nerve pain that occurs as a result of nervous system malfunction or damage. When somatosensory nerve system impairment results in chronic pain from illnesses or injuries, neuropathic pain is a common problem that significantly lowers a person's quality of life. Neuropathic pain originates from several illnesses, including polyneuropathy, trigeminal neuralgia, central poststroke pain, postherpetic neuralgia and postsurgical pain. People with neuropathic pain generally describe feeling intermittent or continuous spontaneous pain, typically described as a scorching, pricking, shooting, pinprick-like, freezing or squeezing sensation (12). This sudden pain may include electric-shock-like spasms, either on their own or simultaneously with continuous discomfort. Furthermore, individuals may experience anomalous sensations including paraesthesia, which is abnormal but not necessarily unpleasant, and dysesthesia, which is both abnormal and unpleasant, either spontaneously or when triggered (13). The correlation between spontaneous and evoked pain in neuropathic situations is intricate. Evoked pain typically complements existing spontaneous pain rather than occurring alone. Spontaneous pain often occurs without provoking pain, indicating similar but separate causes (14). There is strong evidence that early hypersensitivity or evoked pain in conditions such as

postherpetic neuralgia, postsurgical pain and central poststroke pain is an indication of future neuropathic pain (15-17).

1.1.2 Pain treatment

Diseases and their related discomfort necessitate specific therapy to alleviate symptoms or address the root cause. The treatment of disorders such as osteoarthritis with only symptomatic methods might be difficult, since fully rebuilding the natural cartilage biology is frequently unachievable (18). The aim of such treatment is to manage the sickness and symptoms while also impeding or ideally halting the advancement of the illness (19). The choice of therapy is determined by several aspects including the length and severity of the disease, as well as the individual's age, health status and personal expectations (20). Various therapy methods are available, with a preference for conservative treatment in the early stages of the disease. Surgical procedures are only contemplated once all non-invasive treatments have been utilised (20). Because of the diverse demands of individuals and the range of available treatments, there is no one-size-fits-all protocol for every patient.

In the field of orthopaedics, the Association of the Scientific Medical Societies (AWMF) has endeavoured to provide a comprehensive summary of treatment choices and associated recommendations through its guidelines on knee osteoarthritis (21).

1.1.2.1 Pharmacological therapy for pain

1.1.2.1.1 Fundamentals of pain therapy

From a clinical, social and economic perspective, pain causes major problems for the affected individual themselves, as well as the social systems in which they live (22). The treatment of pain also regularly poses major challenges to doctors, and providing adequate analgesia for every patient often appears to be an impossible endeavour. For this reason, and with the aim of providing adequate, individualised and targeted analgesia for all patients, the World Health Organization (WHO) developed a staging scheme in 1986, which was primarily designed for analgesia in cancer patients (23). In this scheme, drugs with different mechanisms of action are used to ensure

balanced and sufficient pain therapy. The following paragraphs describe the components that make up adequate pain therapy, with reference to the WHO staging scheme.

1.1.2.1.1.1 WHO staging scheme

This scheme has been well received by therapists treating the pain of patients without an underlying malignant disease; thus, it is also used in everyday clinical practice as a guideline for such patients. The WHO staging scheme ensures balanced analgesia, leading to reduced use of opioids and, consequently, to a reduction in the risk associated with this group of drugs (23, 24).

The original WHO staging scheme for cancer pain comprises three stages (24, 25):

– Stage 1 (mild pain): non-opioid analgesics (NOPAs)

– Stage 2 (moderate pain): weak opioid with or without NOPAs

– Stage 3 (severe pain): strong opioid with or without NOPAs

Furthermore, the WHO has defined the following treatment maxims for adequate analgesia (24, 25):

“By mouth” – Refers to the preferable oral administration of analgesics.

“By the clock” – Refers to the permanent maintenance of the level of a particular analgesic to ensure a continuous analgesic effect and thus implement adequate basic therapy. Changes in the dose interval should be avoided, and the next dose should not be administered after the end of the duration of action of the previous dose. This approach results in significantly lower doses of analgesics, as only pain peaks need to be intercepted with a short-acting, potent analgesic.

– “By the ladder” – Adherence to the three analgesic stages ensures adequate, balanced analgesia and the highest possible level of patient safety.

In 1996, two further treatment maxims were added (24, 26):

– “For the individual” – Analgesia always refers to the individual being treated and not to strict dosage regimens. Different patients require different treatment regimens and also different doses of analgesics or adjuvants.

– “Attention to detail” – Owing to the individuality of the patient, individual differences must also be addressed in pharmacological and non-pharmacological therapy through a multimodal approach. Namely, not every patient is equally suitable for every therapy for psychosocial reasons.

The following section describes the various analgesics available for use in the WHO staging scheme.

1.1.2.1.2 Analgesics

1.1.2.1.2.1 Non-opioid analgesics

As the term NOPA implies, this group includes all analgesically active drugs that do not bind to opioid receptors. It includes all non-steroidal anti-inflammatory drugs (NSAIDs), as well as paracetamol and metamizole, which are also classed as a special position in the group of NOPAs owing to their mechanism of action (27-29).

Non-steroidal anti-inflammatory drugs

This group includes all substances that have an analgesic effect due to the reversible inhibition of cyclooxygenase 1 (COX-1) and COX-2 and, consequently, the reversible inhibition of prostaglandin synthesis and thus the development of pain. A further effect of COX inhibition, especially that of COX-1, is the consecutive inhibition of thromboxane, which results in vasoconstriction and reduced platelet aggregation (28, 29). There are two further subgroups in the group of NSAIDs: non-selective COX inhibitors and selective COX-2 inhibitors, known as coxibs (27-29).

Non-selective COX inhibitors

Substances in this group inhibit both COX-1 and COX 2, and thus exhibit both the desirable and undesirable effects of inhibiting both cyclooxygenases. The most important effects are analgesia and anti-inflammatory. Adverse drug reactions include gastrointestinal (e.g., gastritis and ventricular and duodenal ulcers), renal (e.g., acute renal failure) and cardiovascular side effects (e.g., arterial hypertension) (27-29). Representatives of this group are diclofenac, ibuprofen, dexibuprofen, acetylsalicylic acid, naproxen and indomethacin.

Coxibs

Substances of the coxib group selectively inhibit COX-2 and thus counteract the development of pain by inhibiting prostaglandin synthesis. Coxibs have analgesic and anti-inflammatory effects. Their most important side effect is increased cardiovascular risk, caused by the inhibition of the anti-aggregatory prostaglandin I2. Consequently, coxibs are contraindicated in patients suffering from coronary heart disease. Similarly to non-selective COX inhibitors, gastrointestinal and renal side effects can also be observed (24, 27-29). Representatives of this group are celecoxib, etoricoxib and parecoxib (27-29).

1.1.2.1.2.2 Paracetamol

Paracetamol occupies a special position among the NOPAs, and its mechanism of action has not yet been fully clarified. In common with NSAIDs, this p-aminophenol acts mainly by inhibiting COX-2 in the CNS (30). This results in the analgesic and antipholgistic effect of paracetamol, and paracetamol also acts on endogenous cannabinoid receptors. In addition, it has been proposed that the effect of paracetamol involves the inhibition of a COX isoenzyme that does not correspond to COX-1 and COX-2 and is therefore called COX-3 (31).

1.1.2.1.2.3 Metamizole

Metamizole, known as novamine sulfone or dipyrone, also occupies a special position among the NOPAs. Despite numerous intensive pharmacological studies, its mechanism of action has not been fully clarified (32). Metamizole and its main metabolites, 4-N-methylaminoantipyrine (MAA) and 4-aminoantipyrine (AA), have both central and peripheral inhibitory effects on prostaglandin synthesis (33, 34). Similarly to paracetamol and NSAIDs, the inhibition of prostaglandin synthesis involves the inhibition of cyclooxygenases, predominantly COX-2 (35). Another central effect of metamizole is based on the theory that it leads to the release of endogenous opioids (32, 36-38). Further effects in the CNS have been proposed to be caused by the inhibition of the neurokinin-1 response and the agonistic effect on the glutamatergic system of the CNS (39, 40). In addition to its analgesic effect,

metamizole has a strong antiphlogistic effect, which is primarily due to central COX inhibition (41).

1.1.2.1.2.4 Opioids

Opioids are substances whose effects are manifested through binding to the body's opioid receptors. A distinction must be made between natural and synthetic drugs. To understand the mode of action of opioids, it is important to know the associated receptors and their spectrum of action with agonistic and antagonistic binding (28, 29, 42). The receptors and their corresponding effects are as follows:

- μ-receptors: associated with strong analgesia (spinal and supraspinal), respiratory depression, constipation, miosis, euphoria, bradycardia, addiction
- κ-receptors: associated with analgesia (predominantly spinal), dysphoria, sedation
- δ-receptors: associated with analgesia, respiratory depression, tolerance development, addiction

All these receptors can act both centrally and peripherally. The analgesic potency of an opioid when administered intravenously is described relative to that of morphine (28, 29, 42).

Weak opioids

Tramadol is the main representative of this group. This drug is indicated for moderately severe pain and is associated with the second stage of the WHO staging scheme (24, 29). Similarly to other opioids, its concomitant use with monoamine oxidase inhibitors is contraindicated (28). Tramadol has an analgesic potency of 0.1 (43).

Strong opioids

Piritramide and hydromorphone are the most commonly used strong opioids in Austria for pain therapy outside of anaesthesiological procedures. Piritramide has an agonistic effect on the opioid receptors, particularly on μ-receptors. Although its full effect is exhibited after approximately 20 minutes, it has a relatively long duration of action of 6 hours (44). Hydromorphone, a derivative of morphine, also has an

agonistic effect on the opioid receptors, with particular affinity to μ-receptors. It has an analgesic potency of 5 to 6 (43).
Fentanyl is another strong opioid. It has an analgesic potency of 100, making it one of the most potent opioids used in non-anaesthesiological settings. Intravenous administration requires constant airway management, because its effect, which occurs primarily at μ-receptors, results in severe respiratory depression (43-45).

1.1.2.1.3 Adjuvants

In addition to the classic analgesically active substances, the WHO staging scheme recommends drugs whose primary effect is non-analgesic for each stage. These substances, which are referred to as adjuvants in pain medicine and catalyse the effect of analgesics in a multimodal manner, include antidepressants, steroids, anticonvulsants, neuroleptics, triptans and α-agonists (24).

1.1.2.2 Non-pharmacological measures

Non-pharmacological measures are prioritised according to internal criteria in pain therapy at our department, with their value ranked in decreasing order. Nursing interventions are crucial and prioritised on the basis of their significance. The non-pharmacological interventions of nursing staff mostly involve therapeutic conversations, meticulous dressing care, and the monitoring and securing of drains. Priority is given to reducing pressure in the operative area by elevating the legs and/or upper torso, relaxing the abdominal wall, or employing an air ring following surgery in the vulva area. Additional non-pharmacological interventions include the use of skincare products, the promotion of movement where feasible for patient comfort, and the provision of fennel tea to alleviate flatulence. Non-pharmacological interventions are chosen with consideration of the fever pattern and may involve the use of ointments or the application of heat or cold, such as through steam wraps or ice packs. This tailored prioritisation enables the focused and efficient incorporation of non-pharmacological methods into pain management to effectively address the specific requirements of individuals.
Non-pharmacological pain management also involves prioritised physiotherapeutic interventions. The primary focus is on engaging in therapeutic dialogue, then placing

the patient in a supine or lateral position through the use of supporting tools. Priority is given to respiratory treatment and the prevention of thrombosis. Afterward, the patient performs low-pain mobilisation by adopting supine, lateral and transverse bed postures as well as standing and walking. Active and passive movement therapy are both essential, along with relaxation methods and interventions to control muscle tone. The physiotherapy interventions are ranked on the basis of the patient's specific assessment results. Pain-free mobilisation is carefully extended to several postures to enhance mobility. Specific physiotherapy treatments are selected from a predetermined list according to the patient's individual requirements and diagnosis. This approach satisfies the need to combine non-drug pain management with physiotherapy, with the therapies selected according to the patient's condition.

1.1.2.3 Patient initiative

Active patient engagement in their pain management is crucial throughout the postoperative phase. Consistent instruction and encouragement from medical professionals motivate patients to be proactive. Patients can be encouraged to adopt strategies such as precise placement on the unaffected side of the body and micro-positioning to obtain the greatest pressure reduction. Furthermore, patients are advised to use cushions or seat rings to alleviate pressure and utilise the bed-adjusting feature, including motorised options. Special emphasis is placed on the importance of opening or loosening abdominal bandages or girdles when lying down to safeguard the wound region. In addition, patients should minimise the pressure applied to the wound region while coughing to reduce discomfort. Dietary considerations, such as avoiding foods that cause flatulence, are also important. The use of appropriate mobilisation strategies is advised to enhance the recuperation process. Patients should promptly report any discomfort and utilise the call system for assistance. Furthermore, patients are advised to engage in activities such as listening to music, watching TV and reading to enhance general well-being and decrease their attention to their pain. Promoting the patient's self-motivation through thorough training and ongoing encouragement is a crucial aspect of complete postoperative pain management.

1.1.2.4 Clinical psychologists and social workers

There is a growing body of research supporting the importance of clinical psychologists and social workers in orthopaedic and trauma units. Patients undergoing orthopaedic and trauma surgery face both physical and emotional obstacles throughout therapy, with research demonstrating that pain, trauma and rehabilitation can have both physical and emotional effects (46).

Clinical psychologists are essential in treating psychological suffering related to orthopaedic procedures, such as anxiety, sadness and stress. Integrating psychological therapy can enhance patient mental health and satisfaction and support pain management (46).

Social workers are crucial for addressing the social determinants of health. They can inform patients of options for post-discharge assistance, aid rehabilitation at home and assist in the transition from inpatient care to home-based therapy. Social workers can also recognise social and financial stressors that might affect the process of rehabilitation (47).

Research indicates that including clinical psychologists and social workers in orthopaedic and trauma teams enhances patient treatment by addressing physical healing, mental health and social adjustment, thus highlighting the growing necessity for a multidisciplinary approach to comprehensive patient care in orthopaedic wards.

1.2 Pain Scheme at University of Graz

A thorough review of the current pain management protocol was conducted at LKH University Hospital Graz under the leadership of Univ.-Prof. Dr Andreas Sandner-Kiesling, pain medicine commissioner at the Department of Orthopaedics and Traumatology. The main goal of this review was to improve the effectiveness of pain treatment in the department by following current research findings and evidence-based standards for pain management in orthopaedics and trauma surgery. The review began with a comprehensive assessment of the existing status of pain treatment in our division. This involved a thorough evaluation of the current pain management strategy; the dispensing of prescribed pain medications; the use of pain assessment methods; and compliance with preoperative, intraoperative and postoperative protocols for managing acute and chronic pain. We then carefully

examined the most recent research results and evidence-based guidelines in the field of pain treatment for orthopaedics and accident surgery to help update the pain management protocol.

Experts from different professions, such as orthopaedic surgeons, trauma surgeons, anaesthesiologists, nurses, clinical psychologists, physical therapists, occupational therapists and social workers, cooperated closely in multidisciplinary sessions to revise the pain schema. To ensure comprehensive treatment, their diverse perspectives and backgrounds were considered. The pain experts consistently observed, evaluated and made the required changes to the adjusted pain regimen. Further talks were conducted with representatives of relevant departments to ensure the execution of these changes. After the improved pain regimen was developed, medical staff received training to support its accurate implementation. The pain management strategy is implemented continuously under the oversight of physicians. The schema is frequently assessed and updated as needed to obtain the intended outcomes. An update to the electronic fever curve, a graphical representation of an individual's body temperature over a specific period of time, typically plotted with temperature on the vertical axis and time on the horizontal axis, commonly used to track fever progression and monitor response to treatment, scheduled for the future, has not been deployed as of February 2024. The major goals of pain management are to achieve optimal results for patients and ensure that their pain is effectively managed, as part of an ongoing process.

1.2.1 Structure of the pain scheme

Dividing the pain scheme into three categories based on the anticipated degree of postoperative pain is a crucial advance in optimising pain management strategies. These categories are used to predict the intensity of pain following surgical operations and help provide suitable basic and on-demand pain relief drugs accordingly. Assigning surgical procedures to the three pain levels (stages) allows a precise evaluation of the anticipated postoperative pain intensity and serves as the foundation for a specialised pain management plan. Stage 1 comprises treatments including arthroscopies, metal removal, biopsies, kyphoplasty, soft tissue procedures and forefoot surgeries. Patients are expected to experience mild discomfort that

warrants a moderate amount of simple pain-relieving medicine. Stage 2 includes minimally invasive stabilisation of the limbs and spine, total hip arthroplasty (THA), osteotomies and arthrodesis, where the anticipated mild discomfort requires more fundamental pain-relieving drugs. Stage 3 is associated with extreme pain, especially during surgical operations including open reduction internal fixation of the extremities, spine or pelvis; total knee arthroplasty (TKA) and total shoulder arthroplasty; shoulder surgery; revision surgery; and major tumour surgery. This categorisation enables the provision of specialised pain management customised to each patient's needs.

For Stage 1 procedures, where minimal pain is anticipated, the use of a limited amount of a suitable fundamental medicine is advised. For Stage 2 procedures, when significant pain is anticipated, the standard analgesic drug three is linked to the anticipation of intense pain, and a highly effective fundamental medicine is given.

A multidisciplinary panel of professionals developed a systematic classification of surgical techniques based on these three stages. This group included seasoned specialists in anaesthesia and pain management, together with skilled senior physicians and leaders in the disciplines of orthopaedics and traumatology. Engaging professionals from these fields guarantees a well-rounded and thorough assessment of pain levels. The specialised knowledge of optimal pain management of anaesthetists and pain experts was paired with the experience of orthopaedic surgeons and traumatologists in specific surgical techniques. This collaborative approach guarantees that pain levels are based on scientific principles and focused on practical application to enable successful and patient-centred pain management.

Medicine can also be given on demand according to the patient's response and pain needs, following the criteria in Figures 1–3. This tailored strategy guarantees personalised pain management that aligns with the needs of the postoperative period.

1.2.2 Extensions of the pain scheme

Specific changes were made to the pain scheme to enable accessibility and applicability for medical workers of all training levels. The improvements focus on including preventive measures for potential responses following the intake of

medication. They encompass preventive strategies for coughs and opioid-induced constipation; thorough anti-nausea and vomiting treatments; and targeted therapy for addressing respiratory depression, agitation/delirium and sleep problems, especially those related to anxiety (Figure 2). These supplementary factors give workers a thorough comprehension of the preventive and supportive strategies linked to pain management. Furthermore, the pain management plan has been extensively updated to incorporate the contraindications and adverse effects of specific analgesic drugs. It is essential to guarantee the safe and efficient use of prescription analgesics (Figure 3). This information allows medical personnel to choose an appropriate analgesic drug, anticipate potential dangers and adverse responses, and take necessary precautions. The broadened pain treatment plan provides a comprehensive and pragmatic method for managing pain by considering other areas of patient care alongside pain alleviation.

Gegenanzeigen:

Diclofenac, Ibuprofen, etc. (NSAR):	Allergie, NINS (GFR < 50mg/dl), Ulcus(-anamnese), zerebro- oder kardiovaskuläre Erkrankungen, NYHA 2-4, PAVK, Asthma bronchiale **CAVE** signifikante Risikofaktoren für kardiovaskuläre Ereignisse
Lorazepam:	Myasthenie, Alkohol-, Psychopharmakaintoxikation, Schlafapnoe-Syndrom, Ateminsuffizienz, Schock, Leber-, Nierenversagen.
Metamizol:	Allergie, hämatologische Erkrankungen, Hypovolämie, Bradykardie, schwere Leber- und Nierenfunktionsstörung, Asthma bronchiale
Droperidol (Neuroleptika):	QT-Verlängerung, Hypokaliämie, Hypomagnesiämie, Bradykardie, Phäochromozytom, Koma, Parkinson, schwere Depression
Paracetamol	Allergie, Schwerer Leberschaden, Alkoholabusus
Piritramid, Hydromorphon (Opioide):	Bestehende Atemdepression, schwere COPD, paralytischer Ileus, schwerer Leberschaden
Tizanidin:	Schwere Leber- und/oder Nierenschäden

Nebenwirkungen:

Diclofenac, Ibuprofen, etc. (NSAR):	gastrointestinale Komplikationen, Blutungen, Niereninsuffizienz, Herzinsuffizienz, Gefäßverschluss, Insult, Herzinfarkt **Neodolpasse®:** Epilepsieneigung, anticholinerges Syndrom
Lorazepam:	Sedierung, Schläfrigkeit, Hypotonie, psychische und paradoxe Reaktionen, (anterograde) Amnesien, Atemdepression, Anaphylaxie
Metamizol:	Anaphylaxie, Leukopenie/Agranulozytose, Asthmaanfall, Hypotension/Schock (i.v.: langsam!)
Droperidol (Neuroleptika):	Benommenheit, Hypotonie, ZNS (Krämpfe), Psyche, Überempfindlichkeit, Arrhythmien, Haut, plötzlicher Herztod
Paracetamol	Leberversagen (TMD: Mexalen 2000mg, Perfalgan 4000mg)
Piritramid, Hydromorphon (Opioide):	Übelkeit, Obstipation, Atemdepression, Verwirrtheit, Müdigkeit, Dyspnoe
Tizanidin:	Müdigkeit, Diarrhoe, Obstipation, Leber, Blutdruckabfall. Bei höheren Dosen Ataxie, Verwirrtheit, Kopfschmerzen, Muskelschwäche

Figure 1: Three-stage pain scheme of LKH University Hospital Graz. © Prof. Sandner-Kiesling & Patrick Reinbacher, MD, MA (Page 3/3)

Landeskrankenhaus - Universitätsklinikum Graz

Universitätsklinik für Orthopädie und Traumatologie

Steiermärkische Krankenanstaltengesellschaft m.b.H. *Medizinische Universität Graz*

Einteilung der Eingriffe in 3 Stufen:

Stufe 1 = geringe Schmerzen zu erwarten	z.B. Arthroskopie, Metallentfernungen, Biopsie, Kyphoplastie, Weichteileingriffe, Vorfuß-Operationen, etc.
Stufe 2 = mittelstarke Schmerzen zu erwarten	z.B. minimal invasive Stabilisierungen an Extremitäten und Wirbelsäule, Hüft-TEP, Umstellungsoperationen, Arthrodesen, etc.
Stufe 3 = starke Schmerzen zu erwarten	z.B. ORIF an Extremitäten /Wirbelsäule /Becken, Endoprothetik (Knie, Schulter), Schulter-Operationen, Revisionen, große Tumorchirurgie, etc.

<table>
<tr><th>Operations-stufe</th><th colspan="3">Basismedikation</th><th colspan="3">Bedarfsmedikation / Schmerzprävention: Schmerz ≥3 (Ruhe) oder ≥5 (Belastung)</th></tr>
<tr><td rowspan="3">Stufe 1</td><td colspan="3">Ab dem OP-Tag</td><td colspan="3">Ab dem OP-Tag</td></tr>
<tr><td colspan="3">Diclofenac 50 mg 3x 1 p.o.</td><td colspan="3">Metamizol 30 gtt max 4x 1 p.o.</td></tr>
<tr><td colspan="3">Alternativ / Unverträglichkeit:
Metamizol 500 mg FTBL 4x 1 p.o.</td><td colspan="2">Alternativ / Unverträglichkeit:
Paracetamol 500 mg max. 4x 1 p.o.</td><td>optional:
Hydromorphon 1,3 mg max.4x 1 p.o.</td></tr>
<tr><td rowspan="3">Stufe 2</td><td>OP-Tag</td><td>Tag 1-3</td><td>danach</td><td>OP-Tag</td><td>Tag 1-3</td><td>danach</td></tr>
<tr><td>Diclofenac/Orphenadrin 250 ml 1-0-1-0 i.v.
Metamizol 1 g ad KI 1-1-1-1 lgs. i.v.</td><td>Diclofenac 50 mg 1-1-1 p.o., plus
Metamizol 500mg FTBL 1-1-1-1 p.o.</td><td>Diclofenac 50 mg 1-1-1 p.o.</td><td rowspan="2">Piritramid 7,5 mg ad KI max. 4x 1 über mind. 30 min i.v.</td><td rowspan="2">Hydromorphon 1,3mg max 4x1 p.o.</td><td>Metamizol 500mg FTBL max 4x 1 p.o.</td></tr>
<tr><td>NOPA-Alternativ / -Unverträglichkeit:
Paracetamol 1 g 1-1-1-0 i.v.</td><td colspan="2">NOPA-Alternativ / -Unverträglichkeit (so nicht schon verordnet):
Metamizol 500 mg FTBL 1-1-1-1 p.o.
Paracetamol 500 mg 1-1-1-1 p.o.</td><td>Metamizol-Alternativ / Unverträglichkeit:
Paracetamol 500 mg max. 4x 1 p.o. (so nicht schon verordnet)</td></tr>
<tr><td rowspan="4">Stufe 3</td><td colspan="2">OP-Tag bis max. Tag 2</td><td>danach</td><td colspan="2">OP-Tag bis max. Tag 2</td><td>danach</td></tr>
<tr><td colspan="2">Diclofenac/Orphenadrin 250 ml 1-0-1-0 i.v. plus
Metamizol 1 g ad KI 1-1-1-1 lgs. i.v., plus
Piritramid 7,5 mg 1-0-1-0 ad KI über mind. 30 min i.v.</td><td>Diclofenac 50 mg 1-1-1 p.o. plus
Metamizol 500mg FTBL 1-1-1-1 p.o., plus
Hydromorphon 2mg ret 1-0-1 p.o. (für 3 Tage)</td><td colspan="2" rowspan="2">Piritramid 7,5 mg max. 4x 1 ad KI über mind. 30 min i.v.</td><td rowspan="2">Alternativ / Unverträglichkeiten:
Hydromorphon 1,3mg max 4x1 p.o., oder
Paracetamol 500mg max. 4x1 p.o. (so nicht schon verordnet)</td></tr>
<tr><td colspan="2">NOPA-Alternative / bei Unverträglichkeit:
Paracetamol 1 g 1-1-1-0 i.v.</td><td>NOPA-Alternative / bei Unverträglichkeit:
Paracetamol 500 mg 1-1-1-1 p.o.</td></tr>
<tr><td colspan="6">Alternativ PCA oder PCEA → CAVE: dann gilt ausschließlich die Schmerz- und Schlafmedikation am PCA-Protokoll!</td></tr>
</table>

Medikamentöse Schmerzschemata Operativer Bereich, Version 10.02.2024

Figure 2: Three-stage pain scheme of LKH University Hospital Graz. © Prof. Sandner-Kiesling & Patrick Reinbacher, MD, MA (Page 1/3)

Präventivmaßnahmen:

Husten	Guaifenesin-Codein Tropfen 30gtt max. 3x1 **Alternativ:** Dihydrocodein Tropfen 20gtt max. 3x1
Opioidinduzierte Obstipation	Laut Stationsstandard, evtl. plus Naloxegol 25mg 1-0-0 p.o. (CAVE NINS → 12,5mg p.o.)
Magenschutz bei NSAR > 5d und/oder pos. Risikoanamnese	Esomeprazol 20 mg 1-0-0 p.o. (zur Prophylaxe) oder 40mg 1-0-0 p.o. (zur Therapie); **alternativ** Pantoprazol
Postoperativer Wundschmerz	Wundrand- oder subfasziale Infiltration im OP (z.B. mit Ropivacain 0,5%)
Schmerz beim VAC-Wechsel	Xylocain 1%-Infiltration ins VAC bei geklemmtem VAC-Drain
Schmerz bei Zystoskopien	5ml Lidocain 2% plus 1 Instillagel steril gemischt, damit die Harnröhre vorgefüllt, Penisklemme für 3 Min.
Verspannung	Tizanidin 2mg 0-0-0-1 p.o.
Tenesmen (z.B. Harnkatheter)	Butylscopalamin 10mg 1-1-1 p.o.

Übelkeit und Erbrechen:

Stufe 1	Ondansetron 4 mg i.v. (TMD 32 mg) **alternativ** Ondansetron 4mg s.l.
Stufe 2	Droperidol 1,25 mg i.v. oder als KI (= 1A.)
Stufe 3	Dexamethason 4 mg /KI i.v.

Atemdepression

Susp. Opioid-bedingt	Naloxon 0,08 mg repetitiv i.v. (Opioidantagonist; =1 Amp./0,4mg auf 10ml mit NaCl 0,9% verdünnt --> 2ml repetitiv i.v.)
Susp. Benzodiazepin-bedingt	Flumazenil 0,1 mg repetitiv i.v. (Benzodiazepinantagonist; =1ml der 0,5mg Amp. unverdünnt repetitiv i.v.)

Unruhe / Delir

	Lorazepam 2mg/250ml NaCl i.v. (TMD 6-8mg, CAVE potenziell atemdepressiv) **alternativ** Lorazepam 2,5 mg s.l.
	Evtl. Clonidin 0,15mg / 50ml NaCl 0.9% Perfusor

Schlafstörung

Angst	Lorazepam 2,5 mg 0-0-0-1 s.l.
Depression	Mirtazapin 30mg 0-0-0-1 p.o. Trazodon 150mg 0-0-0-2/3 p.o.
Einschlafstörung	Zolpidem 10mg 0-0-0-1 p.o.
Durchschlafstörung	Quetiapin 25mg 0-0-0-1 p.o.

Figure 3: Three-stage pain scheme of LKH University Hospital Graz. © Prof. Sandner-Kiesling & Patrick Reinbacher, MD, MA (Page 2/3)

1.3 Volatility, Uncertainty, Complexity and Ambiguity

For a long time, the biological and biomedical components of illnesses almost exclusively dominated the field of medicine. However, in the 1970s the American pathologist George Engel introduced a more holistic perspective to the field of medicine. By incorporating psychological and social aspects into the definitions of health and sickness, he expanded the conventional biological idea of sickness beyond its original boundaries. This led to the development of a biopsychosocial model, which is now recognised as a foundation for medical education in several countries, including Austria (48, 49). This model requires in-depth discussion between a physician and a patient beyond a simple enquiry about biological symptoms. A physician's professional communication should be adjusted to satisfy the unique requirements of each patient, ensuring that the physician not only

acquires clear information but also addresses the patient's anxieties, uncertainties and doubts. Healthcare practitioners must possess comprehensive and adaptable communication skills to meet the wide range of patient needs (50).

In the 1980s, the United States Army War College developed a methodology to better identify, address and manage challenging circumstances that exhibit significant volatility, uncertainty, complexity and ambiguity (abbreviated to VUCA). The VUCA model was developed on the basis of these four qualities with the intention of providing military leaders with a tool to assist them with making judgements in difficult circumstances. In addition to evaluating and classifying complicated circumstances, the VUCA model provides individuals with guidance on how to respond appropriately to problems. The four qualities making up the abbreviation VUCA are used not only to classify the issues but also to suggest responses to such challenges. The developers of the VUCA model provided remedies for its four qualities, which are referred to as VUCA issues or difficulties. These solutions, known as VUCA solutions, involve vision, understanding, clarity and adaptability.

Since its original development, the VUCA model has been used in a wide variety of disciplines, including by executives, crisis managers and economic leaders (51, 52). Both the healthcare industry and patients themselves also face volatile, uncertain, complex and ambiguous situations (53). Thus, the VUCA model also has the potential to enable medical personnel to address these concerns in an effective and professional manner when they interact with patients.

The four qualities are frequently present in situations arising in the emergency department. Thus, there is a connection between the emergency department and the VUCA model. Patients may exhibit many different symptoms and concerns when they arrive in the emergency room, which are not always apparent or unambiguous. In such circumstances, medical professionals are required to react promptly and effectively to satisfy patient requirements and devise suitable treatment strategies.

The VUCA model may be utilised to comprehend and address complex circumstances. By emphasising vision, understanding, clarity and adaptability, it serves as a guide for recognising and responding to complex and unexpected situations. Even under such difficult conditions, medical practitioners may apply these

concepts in the emergency department to promptly diagnose patients and prioritise and devise suitable treatment plans.

In addition, the ideas of the VUCA model may enhance communication and collaboration within a team working in the emergency department by helping establish clear roles and responsibilities and enabling a flexible approach to treatment. Using the VUCA model, the emergency department can improve the quality of patient care while more effectively adapting to the multiple dynamic issues it encounters.

1.4 Local Dexmedetomidine Infiltration

The pain on the first day after surgery is particularly acute, and its severity depends on the type of operation. Because TKA is one of the procedures causing the greatest amount of discomfort, controlling the postoperative pain after TKA can significantly reduce the pain from other surgeries. Pain has a detrimental impact on the progress of rehabilitation, resulting in extended hospitalisation (54-57). Pain has a detrimental impact on recovery and rehabilitation because it can negatively interfere with rehabilitation training and decrease patient activity levels, which may result in the patient being hospitalised for longer (58). Recently, greater emphasis has been placed on multimodal pain therapy, which includes the targeting of different pain pathways, the combined use of opioids, the provision of non-steroidal anti-inflammatory medicines and the administration of periarticular injections or ultrasound-guided regional anaesthesia (USRA) (59). In addition to enhancing the patient's comfort and speed of recovery, the purpose of these multimodal analgesic regimens is to reduce the amount of anaesthetics and opioids required. During TKA, local infiltration anaesthesia (LIA), which is sometimes referred to as periarticular injections, may be utilised as part of multimodal pain treatment to alleviate postoperative pain (60-62). The results of a meta-analysis revealed that patients receiving LIA experienced less pain at 6 and 24 hours after surgery than those receiving a placebo (63). LIA is a simple and rapid administration with minimal side effects, such as a reduced risk of the neurological impairment and muscular weakness associated with peripheral regional anaesthesia (64, 65). This is another reason in favour of the use of LIA. Many practitioners favour LIA because it avoids

the problem of decreased patient motor function following surgical procedures and femoral nerve blockification (66). After TKA, the femoral, sciatic and obturator nerves are the most commonly targeted nerves for postoperative analgesia by USRA. Patients receiving a single-shot femoral nerve block require considerably less opioids in the first 48 hours after surgery than when receiving a placebo (67). To produce better analgesia, blocking of the sciatic nerve in the popliteal area in addition to blocking the femoral nerve has been proposed as a means of achieving the desired analgesic effect (68). In addition, the duration of the block can be lengthened by combining adjuvants such as dexmedetomidine with local anaesthetic compounds (65). Dexmedetomidine is an α2-adrenoceptor agonist that possesses sympatholytic, analgesic and sedative properties. Because of its block-prolonging effect when a single dose of USRA is administered, dexmedetomidine is frequently used as an adjuvant in a local anaesthetic injection (69). This is another compelling argument in favour of using LIA rather than USRA (70, 71). In addition, if dexmedetomidine-supplemented LIA could enhance the analgesic efficacy of ropivacaine and extend the duration of postoperative analgesia after TKA, as previously described for wound infiltration, this would be another advantage of LIA.

One of the primary goals of this dissertation was to investigate the effectiveness of dexmedetomidine as a supplement to LIA in TKA. Its purpose was to assess the impact of utilising dexmedetomidine on postoperative opioid consumption compared with the use of single-shot femoral and popliteal blocks, both of which were coupled with dexmedetomidine. This strategy is an essential component of multimodal therapy, which seeks to integrate several therapeutic approaches to optimise pain management and decrease the requirement for opioids following surgical procedures. Incorporating dexmedetomidine into pain management can produce synergistic effects that reduce postoperative pain severity, thereby reducing opioid consumption. This multimodal strategy is expected to enhance patient care and support overall postoperative recovery.

1.5 Description of Patient Satisfaction Using Example of Total Knee Arthroplasty

In psychology and sociology, satisfaction is defined as a situation in which all expectations or goals are completely fulfilled. Its opposite is dissatisfaction (72). If expectations are fulfilled (confirmation) or exceeded (positive disconfirmation), satisfaction arises; if they are not fulfilled (negative disconfirmation), dissatisfaction arises, described as the disconfirmation paradigm by Klaus Moser in the field of economic psychology (73). From this definition, it can be deduced that expectations are a key determinant of satisfaction.

In the context of TKA, misleading suggestions by industry and the media and in medical recommendations have led to increased expectations, through the use of phrases such as “Your new knee joint will bring new momentum into your life” and claims that TKA will result in a new life, improved partnership, increased attractiveness and sportiness. However, TKA does not result in a physiological knee joint and, contrary to the assumptions of Coelho et al., it does not increase athletic performance or result in weight loss (74). In addition, TKA has no demonstrable effect on reintegration into the workplace, as documented by Lyall et al. (75). Moreover, according to Singh et al., patients undergoing TKA are less satisfied than those undergoing THA (76). Finally, Lützner et al. found that postoperative satisfaction strongly depends on individual expectations, with higher patient expectations before the procedure a significant predictor of positive postoperative satisfaction (77).

Several studies have revealed that the evaluation of the results following TKA is affected by multiple variables. Ritter et al. found that the preoperative Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score is the main predictor of the WOMAC score after 6 months, emphasising the importance of preoperative evaluation as a major determinant (78). Bletterman et al. highlighted the crucial impact of these aspects on the results of TKA in their research on psychosocial factors (79). Phruetthipat et al. conducted research that emphasises a distinct comparison between primary and secondary osteoarthritis, which is discussed in this dissertation as an important influencing element (80). Klem et al. demonstrated the significance of concurrent disorders as an additional factor

affecting the outcome of TKA (81). These findings will help develop a thorough understanding of the many variables affecting the outcome of TKA.

In orthopaedics and rehabilitation, patient satisfaction after TKA is a decisive measure of the success of the operation and the quality of care. Several factors have been identified that influence patient satisfaction. Firstly, freedom from pain after the operation is of central importance. The reduction or elimination of postoperative pain contributes significantly to patient satisfaction. Equally important is the restoration or improvement of the functional capacities of the knee, with a good functional outcome correlating with higher satisfaction. In addition, the fulfilment of the patient's individual expectations plays a decisive role. Studies indicate that satisfaction after TKA depends less on absolute functional levels than on how well the postoperative results match the expectations set before the operation. In addition, patients who experience reduced pain and improved function tend to be satisfied (81). In contrast, failure to fulfil unrealistic expectations, particularly of the elimination of all functional and pain-related problems, leads to reduced or absent satisfaction. These findings emphasise the importance of preoperative counselling to set realistic expectations and of comprehensive postoperative management aimed at relieving pain and improving function to maximise patient satisfaction following knee replacement surgery.

According to the comprehensive review of DeFrance and Scuderi, the general level of dissatisfaction following the initial TKA seems to be around 10% with a range of 5–16% (82). This conclusion was derived from the examination of 21 studies with a combined sample size of 25,235 patients that were conducted between 2010 and 2022 and focused exclusively on primary TKA, excluding alternative forms of knee surgery. The review discovered several influential factors linked to postoperative dissatisfaction, including socio-demographic characteristics such as low income, low educational attainment, social isolation, being female and being under the age of 65. Additionally, preoperative factors such as mild osteoarthritis, depression, anxiety, limited knee joint mobility prior to surgery, previous knee surgery, the presence of multiple other medical conditions and a high body mass index (BMI) were considered. Furthermore, events that occurred after surgery, including suboptimal functional results, discomfort, unmet expectations and the development of comorbidities such as periprosthetic infections, greatly contributed to patient

dissatisfaction. Excluding patients with problems resulted in a reduction in the dissatisfaction rate to 7.3%. These findings highlight the intricate nature of satisfaction following TKA and the numerous aspects that must be considered before and after the procedure to enhance the quality of outcomes and patient happiness.

Multiple methodologies to enhance satisfaction following TKA are now under investigation. In a recent study conducted by Vogel et al., the use of personalised implants was examined in comparison to the use of conventional knee implants (83). No notable disparities in patient satisfaction were observed during a 2-year monitoring period. Shekhar et al. examined various alignment philosophies in THA (84). Furthermore, Choi et al. demonstrated that robotic-assisted surgery enhances functional alignment (85). According to Kaushik, navigational surgery might assist in achieving more accurate alignment during surgical procedures (86). The diverse methodologies outlined in these studies demonstrate encouraging avenues for enhancing surgical procedures and technology in TKA with the aim of increasing patient satisfaction. Additional research and clinical applications are necessary to enhance the long-term effectiveness of TKA and postoperative patient satisfaction.

Implementing preoperative and postoperative assessments is essential for enhancing satisfaction after TKA. Prior to surgery, it is crucial to thoroughly assess the indication, ensure that patients have reasonable expectations regarding the recovery duration and any limits, and provide them with comprehensive information about the potential benefits and dangers of the procedure. Furthermore, it is crucial to improve the patient's preoperative condition by, for example, educating the patient, employing blood-saving techniques prior to surgery and ensuring effective care of the underlying disease. After surgery, it is crucial to ensure that the postoperative care is of excellent quality. Additionally, it is important to utilise advanced perioperative methods such as tranexamic acid medication and local intra-articular analgesia. Providing compassionate care and support following surgery, which includes frequent follow-up exams and physiotherapy, is crucial for facilitating patient recovery and ensuring their satisfaction. By employing these methods, the satisfaction of patients following TKA and other operations can be enhanced, leading to improved long-term results.

1.6 Study Questions

In light of the dynamic and unpredictable nature of healthcare environments encapsulated by the VUCA model, we hypothesise that integrating this model into physicians' communication skills could significantly enhance patient satisfaction with doctor–patient consultations. In this dissertation, I examine how the VUCA factors influence the expectations of orthopaedic patients during doctor–patient relations while simultaneously investigating potential differences in patient satisfaction between ultrasound-guided nerve blocks in the urgent care centre (UCC) and LIA. Moreover, I explore the predictive capacity of certain factors in identifying patients at risk of developing chronic postsurgical pain (CPSP) after TKA, thereby facilitating enhanced postoperative therapeutic interventions.

VUCA Hypothesis

In line with the biopsychosocial model, I hypothesise that integrating the VUCA tool into the communication repertoire of physicians will significantly improve patient satisfaction during doctor–patient consultations.

LIA vs. USRA

I hypothesize that adding dexmedetomidine as an adjuvant for LIA could potentiate the analgesic efficacy of ropivacaine likewise, prolonging the duration of postoperative analgesia.

Neuropathic Pain Hypothesis

Preoperatively identifying patients with an elevated risk of developing CPSP provides an opportunity to implement tailored postoperative interventions, including multidisciplinary approaches such as cognitive behavioural therapy. I hypothesise that the presence of preoperative risk factors for CPSP negatively impacts functional outcomes, leading to increased rates of CPSP among patients following TKA.

2. Materials and Methods

2.1 Volatility, Uncertainty, Complexity and Ambiguity

2.1.1 Patient Selection and Ethical Considerations

Our experiment was carried out as part of prospective cross-sectional observational research in the UCC and the outpatient department (OPD) of the department for orthopaedics and traumatology at a university hospital, which treats many patients. The design of the study made it possible for us to collect data at a single instant in time, eliminating the requirement for further investigation. The candidates participating in the study were chosen on the basis of inclusion and exclusion criteria established prior to our research. We focused on first-time patients and those who had received a referral from an orthopaedic specialist in private practice. Among the inclusion criteria for our patients were an age of at least 18 years old, a first-time visitor to the UCC or OPD, proficiency in German and the signing of an informed permission form. A restricted capacity to provide permission, simultaneous participation in a biopsychological experiment and polytrauma were examples of criteria that we used to exclude participants. To ensure that the study was performed in an ethical manner, a meeting was held with an ethics committee, and the committee granted ethical permission (number 32-253 ex 19/20).

2.1.2 Patient Characteristics and Outcomes

We conducted a survey of patients who were scheduled for elective appointments at our OPD and who were seen at our UCC. The participants were asked about their gender, height and weight, as well as their highest educational level, professional status, early retirement procedures and certificate of disability. After verbally giving consent for participation, patients received a medical educational talk, after which they signed a consent paper for participation. To gain a better understanding of the circumstances of the participants, demographic data was collected. Additionally, information was collected on the date and the nature of the injury (whether it was traumatic or atraumatic), the body area and the referral to a medical professional.

With the assistance of the national rating scale for pain (NRS), the Patient-Reported Outcomes Measurement Information System (PROMIS) was utilised to measure the

everyday physical function of chronic patients and the outcomes of their treatment (87). Additionally, we used PROMIS Scale v1.0 – Pain Intensity 3a to examine the intensity of pain and PROMIS Bank v2.0 to enquire about physical function. Using a computerised adaptive test, we varied the order and nature of the questions on the basis of the replies of the participants.

2.1.3 Questionnaire-Based Investigation for assessing VUCA Factors

We used a different questionnaire to investigate each VUCA factor. For the volatility component, Acceptance and Action Questionnaire II (AAQ-II) was utilised, which had a minimum possible value of 7 and a maximum possible value of 49 (88). According to Bond et al., a score of 24 or higher corresponds to significant distress, whereas a score of a patient with no psychiatric disorder is around 18 (88). To evaluate uncertainty, we devised a condensed version of the Intolerance of Uncertainty Scale (IUS-12), for which values of 12 and 60 represent the least and greatest amount of intolerance to uncertainty respectively (89). A score of 28 on IUS-12, which was developed for diagnosing general anxiety disorder (GAD), has been considered the threshold for the diagnosis of GAD (89, 90). We used the Need for Cognitive Closure Scale (16-NCC) to evaluate the VUCA factor of complexity, for which the range of scores is 16–96. Kruglanski et al. found that scores of 16–32 indicated little need for cognitive closure, while scores of 80–96 corresponded to an excessive need for cognitive closure (91). We used the Intolerance of Ambiguity Scale (IOA) to evaluate intolerance of ambiguity, the lowest possible score for which is 16 and the maximum score is 112 (51, 92). Budner et al. obtained a mean score of 44 to 48 for an American research population (51), although some participants obtained the maximum score of 112 (51, 92).

2.1.4 Patient Satisfaction

Prior to their consultation with the physician, the patients completed the above questionnaires. No details of the research methodology were given to the collaborating physicians. Following the consultation between the patient and the physician, a post-interventional survey was carried out to evaluate the patients' point

of view about whether or not the physician who was consulted offered VUCA solutions during the consultation. Patients were asked to assess the VUCA solution items on a scale from 0 to 5 and their overall satisfaction with the consultation on a scale from 0 to 10. All the data supplied by the patients was evaluated and saved using the REDCap® internet platform (93). It was possible for staff involved in the study to watch the survey procedure using a different tablet or computer to ensure that all data was collected. Following the consultation between the patient and the physician, we examined the relationship between the patients' expectations and their level of satisfaction.

2.1.5 Statistical Analysis

The mean and standard deviation (SD) of the numerical data, such as the age, height, weight and BMI, were used to describe the data. To study the different characteristics in our surveys, we carried out a bivariate analysis that included both correlation and regression analyses. An inductive statistical analysis was performed on the study population with the aim of drawing statistical inferences. Our hypotheses were developed using exploratory statistical processes, which allowed us to assess patterns to construct them. STATA 17 software (94) was used for all the computations.

2.2 Local Dexmedetomidine Infiltration

Our research to evaluate the effectiveness of local dexmedetomidine infiltration at the medical university of Graz in spring 2021. Following written informed consent from the patients and the definition of the exclusion criteria (pregnancy, breastfeeding and/or an existing allergy to study medication), all patients with planned TKA and existing severe knee osteoarthritis were included. Diagnoses were confirmed using radiographs (Kellgren–Lawrence score III/IV).

We randomly allocated patients into two groups, an LIA group and a USRA group, in a 1:1 ratio using web tools for randomisation (https://www.randomizer.at) from the Institute for Medical Informatics, Statistics and Documentation at the local university. The patients were informed about their allocation. The LIA group was given periarticular treatment by the surgeon as described below, and the USRA group was

treated by the anaesthesiologist using ultrasound-guided nerve blocks. In addition, all patients were given spinal or general anaesthesia immediately before the procedure. To minimise any carry-over effect, remifentanil was always used as part of the general anaesthesia to avoid postoperative distortion by longer-acting analgesics.

2.2.1 Local infiltration anaesthesia procedures and regional anaesthesia

The group treated with periarticular infiltration received 60 ml of ropivacaine 0.5% and 1 ml of dexmedetomidine (100 µg ml^{-1}) infiltration of the knee joint including the distal capsule (blockade of the distal fibres). The procedure was carried out after inserting tibial and femoral prosthetic components or before skin closure, and thus the capsule, the surrounding soft tissue and the subcutaneous soft tissue were reached.

Patients assigned to the USRA group and treated preoperatively by the anaesthesiologist using ultrasound-guided nerve blocks received two single-shot nerve blocks (femoral nerve and sciatic nerve 3 cm distal to its popliteal division). The blocks were performed under sterile conditions, with the patient in the supine and in-line position; 15 ml of ropivacaine 0.5% and 0.5 ml of dexmedetomidine (100 µg ml^{-1}) were injected. In the postoperative setting, all patients were placed on a standardised rehabilitation protocol that began immediately after surgery.

To reduce pain, all patients received the NSAIDs ibuprofen (600 mg) and piritramide (2.5–3 mg boluses). The target value of the NRS, an 11-point numeric rating scale that measures subjective severity from 0 (pain-free) to 10 (worst pain), was <4 at rest and <5 during exercise.

2.2.2 Study endpoints

The primary endpoint of this study was defined as postoperative opioid consumption, which was expressed in oral morphine equivalents (OME) and considered the first 48 hours after the operation. To calculate the morphine equivalent, the ratios were defined as 1 mg morphine intravenously = 1.5 mg piritramide intravenously = 3 mg morphine orally (95, 96).

We also used the NRS to measure the subjective pain perceived by the patients, with the physicians collecting the data blinded to the surgical anaesthesia therapy. The NRS value was measured four times a day for the patients at rest and under stress.
The secondary endpoint was defined as “complications” instead of “duration of treatment”, which is because TKA patients in our hospital are generally admitted to the inpatient setting 1–2 days before the operation and are always treated for 5 days after the operation.
All treatment data collected (opioid consumption and NRS) and all patient medical histories were recorded electronically using the hospital’s internal documentation system (SAP Open Medocs, SAP SE, Walldorf, Germany and EDV GmbH, Debis Systemhaus).
About the study population, implanted prosthetics and randomisation, a subsequent follow-up study was conducted under the same conditions. Whereas the previous study mentioned above (1), in which the analgesia regimes were considered, was concerned with the observation of complications, opioid consumption and patient pain, the clinical results and subjective well-being of the patients were examined in the follow-up over a period of at least 2 years after the operation.

2.2.3 Total Knee Arthroplasty

The implant described above (Attune knee prosthesis; DePuy Synthes, Warsaw, IN, USA) is a comprehensive product (97), the development of which can be amortised from the subjective discomfort rates (up to 21%) of another implant (PFC Sigma TKA; DePuy Orthopaedics) (98). The prosthesis used in this study was first approved for testing in 2011 and received full market approval in 2013 (97, 99). The new design of the femoral component and a new patellar system are emphasised here (100, 101). A central locking system is embedded in the tibial base parts and thus enables improved fixation and ensures a reduction in micro-movements posterior to the prosthesis (102).
For patient allocation, blinding and randomisation, the same procedures were used as in the previous study (1). In addition, the same procedures were used for the placement, the selected preparations, the access routes of the USRA, the materials used and the technique used in the surgery.

2.2.4 Statistical Analysis

Data was expressed as the number of patients (%), median and interquartile range (IQR; 25th to 75th percentile) for non-parametric data and as mean ± SD for parametric data. Kolmogorov–Smirnov and Shapiro–Wilk tests were used to test for data normality, Fisher's exact test was used for univariate analysis of statistical significance, and the Mann–Whitney test was used for non-parametric data. Statistical significance was analysed with a two-sided alpha of less than 5% as the significance level. For exploratory analysis of the data, an adjusted p-value (P_2) of <0.01 was used to account for multiple testing. Rank correlations with Spearman's ρ and logistic regression were used as further analyses. To determine the correlation between LIA procedures and OME requirements, Spearman correlation was used to explore possible correlations between LIA procedures and the NRS score (at rest and during exercise) or OME requirements. The logistic regression models for opioid consumption on OME and postoperative pain were gender (binary), type of anaesthesia (spinal anaesthesia [binary]) and type of local anaesthetic administration (LIA [binary]).

The NRS with a threshold value of <3 or >3 on the second postoperative day and the inequality of the administered OME during the first 48 hours compared with the median of the USRA group (greater than or equal to/less than) were dichotomised. The NRS at 48 hours was chosen because no effect of the local anaesthetics was considered to remain at this time.

After the inclusion of the 50 participants, a safety analysis was performed in consultation with the local ethics committee and the responsible practitioners. A requirement of >10 mg OME for postoperative pain control was defined as significant clinical opioid use. This requirement complies with current CONSORT guidelines. A priori power analysis (Statistical Solutions Ltd. nQuery Advisor version 8.4.1, 2019; Cork, Ireland) was performed on the basis of observations in previous knee arthroplasty studies. It was found by calculation that, for a total sample size of 188 patients (176 plus dropout), there was a significant difference of 13.2 mg OME in the primary endpoint of the median opioid equivalent consumption 48 hours after surgery between the study groups (alpha 5%, Kruskal–Wallis test, 1–β probability of 80%).

In the follow-up, various questionnaires were used for analysis, with functional outcomes defined as endpoints. In detail, the Knee Society Knee Score (KSKS), Knee Society Function Score (KSFS) (103), WOMAC (104), Oxford Knee Score (OKS) (105), Forgotten Joint Score (FJS) (106) and Evaluation du Vécu de l'Anesthésie Loco Régionale in English (EVANLR) (107) questionnaires were used.
The Anesthesiology Follow-up Questionnaire (ANP) was used to investigate any disorders as well as satisfaction and well-being (108).
The patients were examined preoperatively and at 5 days, 6 weeks, 12 months and 24 months after surgery, and a two-armed goniometer was used to measure the range of motion (ROM).
At follow-up, data was expressed as the number of patients in percent, mean (± SD) for parametric data or median (25 to 75 percentile [IQR]) for non-parametric data. The Kolmogorov–Smirnov and Shapiro–Wilk tests were used to test for a normal distribution. The exact test of Fisher was used for univariate analysis of statistical significance, and the Mann–Whitney test was used for non-parametric data. Analysis with a two-sided alpha of less than 5% was used for statistical significance. As further statistical analyses, rank correlation with Spearman's ρ and logistic regression were performed. Spearman correlations were used to assess the possible correlation between the use of LIA and the items of the questionnaires (at rest and during exercise). For the logistic regression models for well-being, type of anaesthesia (general anaesthesia [binary]), type of administration of local anaesthetics (LIA [binary]) and gender (binary) were fitted as covariates. The Likert scores for well-being with a threshold of good (two lowest nuisance scores) and poor (two highest scores) were dichotomised in this logistic regression analysis.
A priori power analysis (Statistical Solutions Ltd. nQuery Advisor) for the endpoints of well-being and clinical outcomes was performed with a difference of 10% for clinical relevance, which indicated that n = 25 per group was sufficient, with a p-value of less than 0.05 and a power of more than 80%. Statistical significance was analysed with a two-sided alpha of less than 5% as the significance level. Correlations were defined as weak for r = 0.10–0.29, moderate for r = 0.30–0.59 and strong for r > 0.59 (reversed for negative correlations).

2.3 Neuropathic Pain

The diagnosis of neuropathic pain is critical for comprehensively assessing the pain in individuals with severe knee osteoarthritis. Examining neuropathic pain allows a focused and personalised pain treatment, as well as a thorough evaluation of the long-term efficacy of various treatment methods beyond the postoperative period. Recording neuropathic pain has a crucial role in enhancing postoperative pain treatment and improving patient care.

In addition to the questionnaires completed by the patients, five additional measures were utilised to thoroughly evaluate the biopsychosocial components of pain: the Short Form 36 (SF-36) (109-111), the Fibromyalgia Survey Questionnaire (FSQ) (112), the Pain Catastrophizing Scale (PCS) (113, 114), the Hospital Anxiety and Depression Scale (HADS) (115) and the Douleur Neuropathique en 4 Questions (DN4) (116, 117).

Furthermore, all patients were examined for the presence of allodynia, and data was gathered on demographics, particular injuries and the duration of the preoperative anaesthesia examination. Information was also obtained about the surgery. The treatment-specific data comprised information on the surgery, such as the surgical approach, the length of surgery, the surgeon's name and the type of implant used. The information also included the type of anaesthesia used and whether it was general anaesthesia or regional anaesthesia.

A panel consisting of two experienced anaesthesiologists and two orthopaedic surgeons analysed the collected data to classify the patients into two groups: a high-risk group (n = 20) and a low-risk group (n = 30). The Grazer pain system was employed to ensure consistent and high-quality care for patients with pain.

Subsequent evaluations were performed on the second day following the surgery, the day of release and at intervals of 6 weeks, 3 months, and 6 months.

3. Results

3.1 Volatility, Uncertainty, Complexity and Ambiguity

3.1.1 Demographic Data

The whole study population had a mean age of 43 years (SD: 17.0) with an age range of 18–82 years. The patients who visited the UCC had a mean age of 40 years (SD: 1.6), whereas the patients who visited the OPD had a mean age of 46 years (SD: 1.7). A p-value of 0.009 (t-test) indicated that patients in the OPD had a significantly greater average age than those in the UCC. Overall, 56.5% of the studied population were females, 43.0% were males and 0.5% of the population identified as non-binary. In the UCC, 49.0% of the patients identified as female, 50.0% identified as male and 1.0% did not identify with either gender. A total of 64.0% of the patients in the OPD were female, whereas 36.0% were male. At the UCC, the mean BMI was 25 (SD: 5), and, as indicated by the p-value of 0.496 (t-test), there was no significant difference between the mean BMI of the OPD population, which was 26 (SD: 5.6), and that of the whole study population, which was also 26 (SD: 5.3). The BMI ranged from 16 to 46. Among the whole study population, 52% of the people visited one of the departments due to injuries that were not considered to be traumatic, whereas 48% visited because of a traumatic injury. At the UCC, 19% of the patients who visited had injuries that were not considered to be traumatic, whereas 81% of the patients were seeking consultation because of trauma. On the other hand, 85% of the patients who attended the OPD did so because of non-traumatic injuries, whereas only 15% visited because of trauma. Additional data is given in Table 1.

3.1.2 PROMIS, AAQ-II, IUS-12, 16-NCC: UCC vs. OPD Comparison

The PROMIS scale was used to evaluate the degree of pain. The whole study population exhibited a mean score of 51 (SD: 8.1) with a range of 31–72. The mean pain intensity was 52 (SD: 7.3) for the UCC and 51 (SD: 8.8) for the OPD, with a p-value of 0.188. PROMIS Bank was analysed for physical function, and the mean for the whole study population was 38 (SD: 9.7) with a range of 17–72. A significant difference was observed between the mean of the UCC, which was 34 (SD: 8.5), and

that of the OPD, which was 42 (SD: 9.3), as indicated by the p-value (t-test) of 0.001 for the physical function. For the whole study population, AAQ-II, the scale used to measure the VUCA factor of volatility, had a mean of 18 (SD: 10.0) with a range of 7–49. For AAQ-II, patients at the UCC exhibited a mean score of 17 (SD: 9.0), compared with a mean score of 20 (SD: 10.0) for patients at the OPD. As indicated by the p-value (t-test) of 0.006, a statistically significant difference was observed between the two departments for the VUCA factor of volatility. The results for IUS-12, the scale used to indicate the intolerance of uncertainty in orthopaedic patients, revealed that the whole study population had a mean score of 29 (SD: 8.7) and a range of 12–60. Patients in the UCC exhibited a mean of 28 (SD: 8.3), compared with a mean of 30 (SD: 8.9) for patients in the OPD. IUS-12 revealed a statistically significant difference between the two groups, with a p-value (t-test) of 0.032. For 16-NCC, the scale used to quantify the VUCA factor of complexity, the whole study population had a mean score of 55 (SD: 13.0) with a range of 27–91.

3.1.3 16-NCC and IOA: UCC vs. OPD Variance

There was a statistically significant difference between the mean scores of the patients at the UCC (52; SD = 13.0) and those at the OPD (58; SD: 12.0) for 16-NCC, as indicated by a p-value (t-test) of 0.001. For IOA, the test used to evaluate the VUCA factor of ambiguity, the mean score for the whole study population was 65 (SD: 8.0), and the range of scores was 40–85. Patients seen at the OPD and the UCC had mean scores of 63 (SD: 8.4) and 67 (SD: 7.2), respectively. The p-value for the VUCA factor of ambiguity was 0.002 in the t-test, indicating a significant difference between the two departments.

3.1.4 Survey Results: Fulfilment of VUCA Solutions Across Departments

The post-interventional survey revealed the following findings regarding the expectation of fulfilment of the VUCA solutions of vision, understanding, clarity and adaptability. For vision, the mean score was 3.6 (SD: 1.4) for the whole study population, with a range of 1–6. Patients of the UCC exhibited a mean score of 3.4 (SD: 1.4), compared with a mean score of 3.8 (SD: 1.4) for patients of the OPD. No

significant difference for vision was observed between the two departments, as indicated by a p-value (t-test) of 0.051. For understanding, a mean of 4.5 (SD: 0.9) and a range of 1–6 were obtained for the whole study population, with patients of the UCC exhibiting a mean of 4.5 (SD: 0.82) and those of the OPD exhibiting a mean of 4.5 (SD: 0.98). For vision, there was no significant difference between the two departments, as indicated by a p-value (t-test) of 0.938. For clarity, a mean score of 3.7 (SD: 1.4) was obtained for the whole study population, with a range of 1–6. Patients of the UCC and the OPD exhibited mean scores of 3.5 (SD: 1.4) and 3.8 (SD: 1.4), respectively. For clarity, there was no significant difference between the two departments, as indicated by a p-value (t-test) of 0.178. Finally, for adaptability, the whole study population had a mean of 3.9 (SD: 1.2) with a range of 1–6, with patients of the UCC having a mean of 3.7 (SD: 1.3) and those of the OPD having a mean of 4.0 (SD: 1.2). For adaptability, there was no significant difference between the two departments, as indicated by a p-value (t-test) of 0.095. According to the results of the post-interventional survey, the whole study population had a mean score of 4.5 (SD: 1.6) for vision. The range of the scores was 1–6, with patients of the UCC having a mean score of 4.5 (SD: 1.6) and those of the OPD having a mean score of 4.6 (SD: 1.6). For vision, there was no significant difference between the two departments, as indicated by a p-value (t-test) of 0.928. For understanding, a mean score of 4.8 (SD: 1.5) was obtained for the whole study population, with a range of 1–6. The mean score for patients in the UCC was 4.7 (SD: 1.5), compared with 4.9 (SD: 1.4) for patients in the OPD. A p-value (t-test) of 0.287 indicated no significant difference between the two departments for these results. The overall mean for clarity was determined to be 4.9 (SD: 1.4) with a range of 1–6. The mean scores for patients in the UCC and the OPD were 4.9 and 4.9 (SD: 1.4), respectively. The p-value (t-test) for the comparison of the two departments for clarity was 0.842, indicating no significant difference between them. The mean score for adaptability for the whole study population was 4.7 (SD: 1.5) with a range of 1–6. The means for the patients of the UCC and the OPD were 4.7 (SD: 1.5) and 4.8 (SD: 1.5), respectively. The p-value for the t-test was 0.742, indicating no significant difference between the two departments for adaptability.

3.1.5 Doctor-Patient Consultation: Similar Satisfaction Levels

For satisfaction with the doctor–patient consultation, the mean for the whole study population was 8.3 (SD: 2.5) with a range of 0–10. The mean for the patients of the UCC was 8.2 (SD: 2.5), compared with a mean of 8.3 (SD: 2.4) for those of the OPD. There was no significant difference between the two departments for satisfaction with the measured doctor–patient consultation, as indicated by the p-value (t-test) of 0.774. For the satisfaction with each VUCA solution factor, the pearson correlation coefficient are 0,68 for vision, 0,78 for understanding, 0,82 for clarity and 0,78 for adaptability were obtained for the whole study population. For vision, the UCC and OPD patients achieved satisfaction of 0,70 and 0,65, respectively, with a significant difference between them ($p < 0.05$).

Parameter	Total (n = 200)			Trauma (n = 100)		Ortho (n = 100)		Difference Trauma-Ortho		
	Value	Std. dev.	Range	Value	Std. dev.	Value	Std. dev.	p-value	95% CI	Test
Age (years)*	43	17	18–82	40	1.6	46	1.7	***.009***	[-10.75; -1.54]	T-test
Sex								***.046***		Fisher exact
Female	113 (56.5%)			49 (49%)		64 (64%)				
Male	86 (43%)			50 (50%)		36 (36%)				
Third	1 (0.5%)			1 (1%)		0 (0%)				
BMI	26	5.3	16–46	25	5.0	26	5.6	*.496*	[-1.99; 0.97]	T-test
Education (years)*	13	3.5	8–40	14	3.9	12	2.3	***<.001***	[1.65; 3.45]	T-test
Working status								**.009**		Pearson chi2
Student	29 (14.5%)			21 (21%)		8 (8%)				
Employed	120 (60%)			62 (62%)		58 (58%)				
Out of work	12 (6%)			4 (4%)		8 (8%)				
Retired	39 (19.5%)			13 (13%)		26 (26%)				
Marital status								*.957*		Fisher exact
Single	57 (28.5%)			28 (28%)		29 (29%)				
Married/couple	118 (59%)			59 (59%)		59 (59%)				
Divorced/separated	20 (10%)			11 (11%)		9 (9%)				
Widowed	5 (2.5%)			2 (2%)		3 (3%)				
Living								*1.000*		Fisher exact
Alone	52 (26%)			26 (26%)		26 (26%)				
Multi-person household	148 (74%)			74 (74%)		74 (74%)				
Smoking habits								*.880*		Fisher exact
No	136 (68%)			67 (67%)		69 (69%)				
Yes	64 (32%)			33 (33%)		31 (31%)				
Alcohol consumption								*.577*		Fisher exact
Never	52 (26%)			22 (22%)		30 (30%)				

1x per month	60 (30%)			29 (29%)		31 (31%)				
2–4x per month	61 (30.5%)			35 (35%)		26 (26%)				
2–3x per week	24 (12%)			12 (12%)		12 (12%)				
≥4x per week	3 (1.5%)			2 (2%)		1 (1%)				
Gross annual salary	n = 199			n = 99				***.004***		Pearson chi2
<€11,200	63 (31.66%)			31 (31.31%)		32 (32%)				
€11,200–17,400	34 (17.09%)			9 (9.09%)		25 (25%)				
€17,400–22,900	18 (9.05%)			5 (5.05%)		13 (13%)				
€22,900–28,100	24 (12.06%)			16 (16.16%)		8 (8%)				
€28,100–33,000	16 (8.04%)			11 (11.11%)		5 (5%)				
€33,000–39,000	16 (8.04%)			11 (11.11%)		5 (5%)				
>€39,000	28 (14.07%)			16 (16.16%)		12 (12%)				
Injury condition								***<.001***		Pearson chi2
Non-traumatic	104 (52%)			19 (19%)		85 (85%)				
Traumatic	96 (48%)			81 (81%)		15 (15%)				
Days since injury	524	1648	0–15,716	6.4	16	1,041	2218	***<.001***	[-1474.95; -594.79]	T-test
Injury region								***.005***		Fisher exact
Head	7 (3.5%)			7 (7%)		0 (0%)				
Neck	7 (3.5%)			4 (4%)		3 (3%)				
Upper extremity	53 (26.5%)			32 (32%)		21 (21%)				
Trunk	31 (15.5%)			10 (10%)		21 (21%)				
Lower extremity	102 (51%)			47 (47%)		55 (55%)				
Allocation								***<.001***		Pearson chi2
Self-assignment	90 (45%)			79 (79%)		11 (11%)				
Referral from the family doctor	41 (20.5%)			14 (14%)		27 (27%)				
Referral from the specialist	69 (34.5%)			7 (7%)		62 (62%)				
*** Values are expressed as mean ± std. dev.**										

Table 1: Characteristics of VUCA study population (n = 200). Unpublished preliminary data.

3.2 Local Dexmedetomidine Infiltration

3.2.1 Patient Participation

Among the 56 eligible patients, four patients declined to participate in the study in writing, and two others were excluded because the procedure was planned for a later date. As a result, 50 patients who did not differ in their initial characteristics were included in the study.

For these 50 patients, a dropout and complication rate of 0% was achieved over a period of 5 days after surgery. The only significant difference between the patients was the difference in the main anaesthetic procedure used (in the group treated with USRA, general anaesthesia was used more frequently, p= 0.037).

The LIA group had a median opioid consumption of 42.0 mg [IQR 24.0–57.0], significantly higher than that of the USRA group (27.0 mg [IQR 0.0–34.0], P = 0.022), in the first 48 hours after surgery.

According to the protocol, which was approved by the Institutional Review Board, the study was rejected for ethical reasons because a difference of 15 mg OME was observed between the two groups, which was also reflected in the higher NRS value of this group (Table 2).

3.2.2 Comparative Analysis of Opioid Consumption and Complications in Post-Anaesthesia Care

Higher opioid consumption was also evident in the post-anaesthesia care unit (PACU), with a median consumption of 12.0 mg [IQR 10.0–20.5] for the LIA group and 0.0 mg [IQR 0.0–18.0] for the USRA group (P = 0.047; Table 3). However, 48 hours after surgery, a significant difference could no longer be observed.

The logistic regressions adjusted for type of anaesthesia (spinal anaesthesia), type of LIA and gender were all non-significant (based on the 95% confidence interval, which includes an odds ratio of 1.0).

No adverse drug reactions or complications of dexmedetomidine were observed during the entire observation period. Both groups were free of vegetative complications after the main anaesthetic procedure, thus avoiding the need for drug therapy (ephedrine, atropine).

After inclusion testing, 50 out of 56 patients were randomised and subsequently analysed (Figure 4). There were no discontinuations or complications that could be related to the procedures, although general anaesthesia was used more often in the USRA group, whereas more patients in the LIA group were treated with spinal anaesthesia ($p = 0.037$). No significant differences were observed in the latter group. In addition, the demographic data and baseline characteristics of the two groups were similar (Table 4).

3.2.3 Wellbeing and Functional Outcomes

Well-being was assessed in the follow-up. The analysis revealed that 10 patients in the LIA group and only three patients in the USRA group reported experiencing well-being 6 weeks after the procedure ($p = 0.024$; Table 4). This effect was not observed during the subsequent postoperative examinations ($p = 1.000$).

With regard to functional abilities, there were only differences in the CPSP values between the two groups 5 days after surgery, with patients in the LIA group reporting higher pain levels ($p = 0.011$). In the subsequent examinations, there were no significant differences in CPSP. Over the entire observation period, there were no differences between the groups in terms of clinical results after TKA implantation (Table 5). This statement also applies to postoperative improvements.

Regarding correlations between the data obtained from the questionnaires and LIA, there was only a moderate correlation between well-being and CPSP 5 days after TKA implantation ($r = 0.401$, $r = 0.362$, $p < 0.01$). When the value for well-being was entered into a logistic regression model with the attributes of the anesthesiological procedure, gender and LIA application, only the performance of the LIA remained significant (Table 6). No significant differences were exhibited for hypalgesia ($p = 0.208$), allodynia ($p = 0.109$) and gender ($p = 0.231$) in a comparison between the LIA and USRA groups. The data was collected postoperatively after 6 weeks, 1 year and 2 years.

	LIA, n = 25	USRA, n = 25	P*
Maximum NRS at rest			
PACU	0.0 [0.0 to 1.8]	0.0 [0.0 to 0.5]	0.091
Day 1	1.0 [0.0 to 3.0]	0.0 [0.0 to 0.5]	0.006
Day 2	2.0 [1.0 to 4.0]	1.0 [0.0 to 3.5]	0.313
Day 3	1.0 [0.0 to 2.0]	1.0 [0.0 to 1.0]	0.621
Day 4	0.0 [0.0 to 1.0]	0.0 [0.0 to 1.0]	0.723
Day 5	1.0 [0.0 to 1.0]	0.5 [0.0 to 1.0]	0.907
Day 6	0.0 [0.0 to 1.5]	1.5 [0.0 to 3.0]	0.267
Maximum NRS during exercise			
PACU	0.0 [0.0 to 2.8]	0.0 [0.0 to 1.0]	0.011
Day 1	2.0 [1.0 to 4.0]	0.0 [0.0 to 2.0]	0.001
Day 2	2.0 [2.0 to 5.0]	2.0 [1.0 to 5.0]	0.282
Day 3	2.0 [1.0 to 3.0]	2.0 [1.0 to 2.5]	0.912
Day 4	1.0 [0.5 to 2.0]	1.0 [0.5 to 2.5]	0.873
Day 5	1.0 [0.5 to 2.0]	2.0 [1.0 to 2.0]	0.345
Day 6	1.0 [1.0 to 4.0]	2.5 [1.0 to 4.0]	0.236

Table 2: Postoperative pain levels of 50 patients who underwent primary total knee arthroplasty. The patients were randomly assigned to receive either local infiltration anaesthesia or ultrasound-guided regional anaesthesia for pain control. Pain score were measured using the numeric rating scale (NRS) at rest and during exercise (1). Reproduced with permission of publisher.

Values are median [IQR]

LIA: local periarticular infiltration anaesthesia technique, *USRA*: ultrasound-guided regional anaesthesia, *PACU*: post-anaesthesia care unit, *NRS*: numeric rating scale

* For multiple testing of NRS values, an adjusted significance value of $P_2 < 0.01$ is applicable.

	LIA, n = 25	USRA, n = 25	P
OME in the PACU	12.0 [10.0 to 20.5]	0.0 [0.0 to 18.0]	0.047
OME on the ward Day 0	15.0 [0.0 to 15.0]	0.0 [0.0 to 0.0]	<0.001
OME in PACU + ward (Day 0)	27.0 [16.5 to 35.5]	3.0 [0.0 to 23.5]	0.001
OME 48 h post TKA (PACU, ward Day 0, Day 1)	42.0 [23.5 to 57.0]	27.0 [0 to 33.5]	0.022
OME on the ward*			
Day 1	15.0 [0 to 15.0]	0.0 [0.0 to 22.5]	0.570
Day 2	0.0 [0 to 15.0]	0.0 [0.0 to 22.5]	0.768
Day 3	0.0 [0.0 to 0.0]	0.0 [0.0 to 15.0]	0.564
Day 4	0.0 [0.0 to 0.0]	0.0 [0.0 to 0.0]	0.267
Day 6	0.0 [0.0 to 0.0]	0.0 [0.0 to 0.0]	0.977

Table 3: Postoperative oral morphine equivalents (OME) of 50 patients who underwent primary total knee arthroplasty. The patients were randomly assigned to receive either local infiltration anaesthesia or ultrasound-guided regional anaesthesia for postoperative pain control (1). Reproduced with permission of publisher.

Values are median [IQR]

OME: oral morphine equivalents, *LIA*: local periarticular infiltration anaesthesia technique, *USRA*: ultrasound-guided regional anaesthesia, *PACU*: post-anaesthesia care unit; OME in mg

*For multiple testing of opioid does, an adjusted significance value of $P_2 < 0.01$ is applicable.

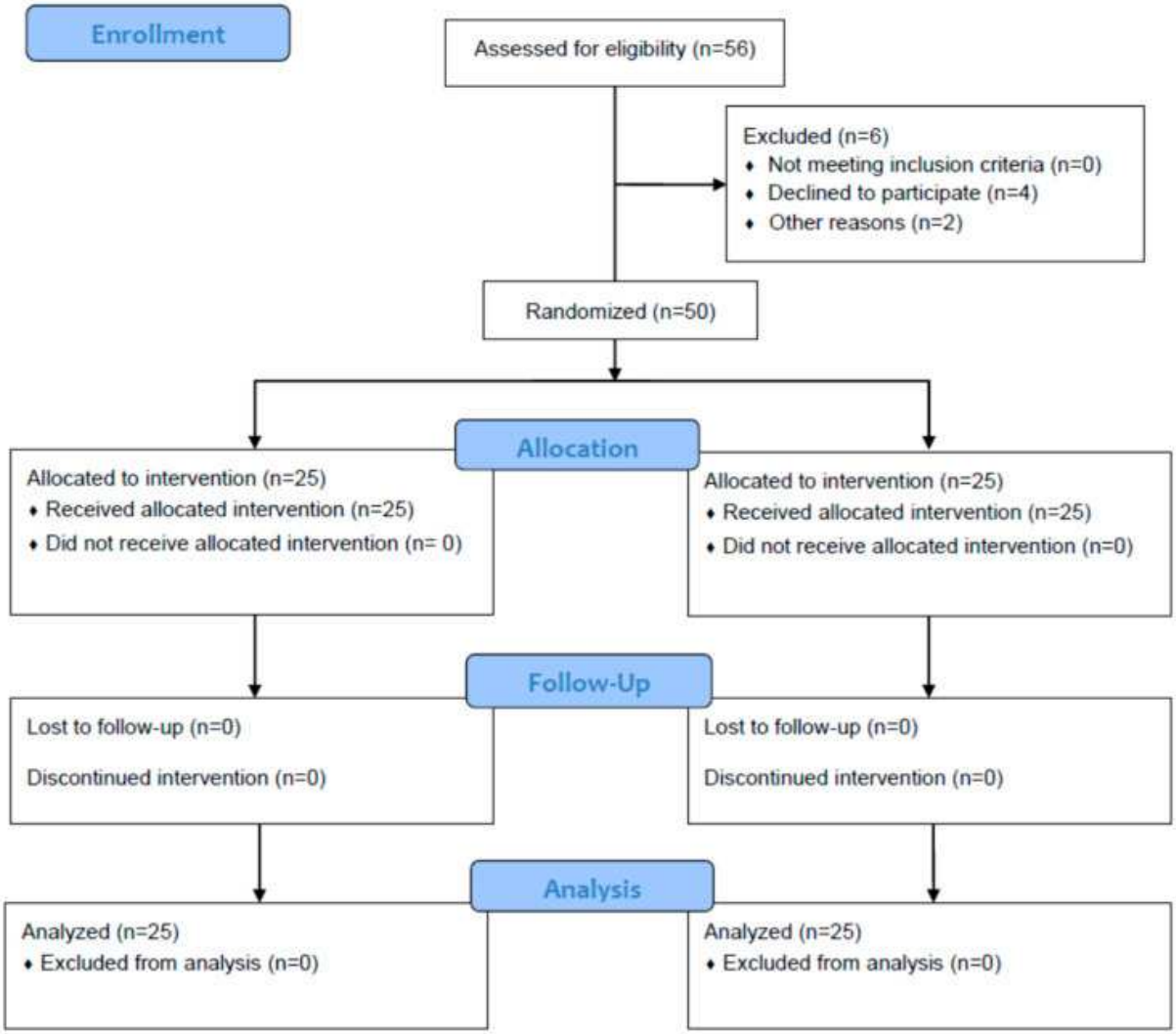

Figure 4: Study enrolment. Fifty-six consecutive patients were screened for eligibility. These patients were randomised into two groups. One group was given local periarticular infiltration anaesthesia (LIA) in the knee capsule during surgery and the other was given two single-shot ultrasound-guided regional anaesthesia (USRA) blocks (2). Reproduced with permission of publisher.

	USRA	LIA	p-Value
	N = 25	N = 25	
Age (years)	67.6 (± 11.0)	68.6 (± 10.2)	0.771
Female (%)	10 (40)	12 (48)	0.569
BMI (kg/m^2)	27.8 [24.3 to 33.8]	28.4 [25.7 to 31.6]	0.734
ASA 1 (%)	1 (4)	0 (0)	
ASA 2 (%)	7 (28)	10 (40)	0.437
ASA 3 (%)	17 (68)	15 (60)	
General anaesthesia (%)	11 (44)	5 (20)	0.037
Spinal anaesthesia (%)	14 (56)	20 (80)	
Days of hospitalisation	6.0 [6.0 to 7.0]	6.0 [6.0 to 7.0]	0.639
Well-being, N (%)			
6 weeks after surgery	No: 22 (88%) Yes: 3 (12%)	No: 15 (60%) Yes: 10 (40%)	0.024
12 months after surgery	No: 5 (11%) Yes: 42 (89%)	No: 4 (9%) Yes: 43 (91%)	1.000
24 months after surgery	No: 5 (11%) Yes: 42 (89%)	No: 4 (9%) Yes: 43 (91%)	1.000

Table 4: Factors considered, which include patient demographics, type of anaesthesia used, length of hospital stay and overall patient satisfaction (2). Reproduced with permission of publisher.

LIA: local periarticular infiltration anaesthesia technique; *USRA*: ultrasound-guided regional anaesthesia; *ASA*: physical status classification system by the American Society of Anesthesiologists.

	USRA (n = 25)	LIA (n = 25)	p-Value
Range of Motion			
Preoperative	105 [100–115]	95 [85–115]	0.412
5 days postoperative	90 [90–100]	90 [90–100]	0.593
6 weeks after surgery	115 [110–120]	115 [110–120]	0.734
12 months after surgery	118 [90–145]	119 [100–145]	0.825
24 months after surgery	123 [100–150]	123 [100–150]	0.241
KSKS Pain			
Preoperative	59 [55–64]	55 [53–67]	0.464
5 days postoperative	65 [62–67]	75 [68–92]	0.011
6 weeks after surgery	92 [89–97]	90 [73–96]	0.907
12 months after surgery	96 [80–100]	95 [87–100]	0.497
24 months after surgery	98 [90–100]	98 [94–100]	0.189
KSKS Function			
Preoperative	50 [50–70]	50 [50–60]	0.565
5 days postoperative	20 [20–50]	30 [30–60]	0.257
6 weeks after surgery	50 [50–70]	50 [50–60]	0.757
12 months after surgery	83 [65–100]	84 [50–100]	0.659
24 months after surgery	93 [65–100]	93 [80–100]	0.643
WOMAC			
Preoperative	57.1 [54.2–63.4]	58.6 [55–62.3]	0.846
5 days postoperative	72.3 [65.9–78]	77.4 [75.1–80.3]	0.081
6 weeks after surgery	90.1 [85.3–94.1]	90.5 [90.3–95.3]	0.294
12 months after surgery	92.6 [86–100]	93.4 [86–100]	0.711
24 months after surgery	94.1 [90–100]	95.8 [90–100]	0.754
OKS			
Preoperative	19 [17–23]	16 [14–22]	0.255
6 weeks after surgery	31 [27–36]	31 [27–36]	0.712
12 months after surgery	38 [28–42]	37 [28–41]	0.862
24 months after surgery	43 [31–45]	43 [32–46]	0.897
FJS			
6 weeks after surgery	48 [47–51]	51 [49–53]	0.090
12 months after surgery	62 [48–75]	63 [49–78]	0.382
24 months after surgery	80 [60–92]	82 [58–94]	0.827

Table 5: Functional outcomes before surgery and at 5 days, 6 weeks, 12 months and 24 months after the initial total knee arthroplasty (TKA) using either dexmedetomidine local infiltration analgesia (LIA) or ultrasound-guided regional anaesthesia (USRA) (2). Reproduced with permission of publisher.

LIA: local infiltration anaesthesia; *USRA*: ultrasound-guided regional anaesthesia (combined femoral and sciatic nerve blocks); *ROM*: range of motion; *KSKS*: Knee Society Knee Score; *WOMAC*: Western Ontario and McMaster Universities Osteoarthritis Index; *OKS*: Oxford Knee Score; *FJS*: Forgotten Joint Score.

	Exp (B)	95% CI for Exp (B)		p-Value
		Lower	Upper	
Male gender	0.622	9 (50%)	30 (86%)	0.009
LIA	5.254	13 (72%)	27 (77%)	0.743
GA	0.748	4 (22%)	11 (31%)	0.539

Table 6: Logistic regression model accounting for the influence of LIA, gender and type of anaesthesia on patient well-being (2). Reproduced with permission of publisher.

Variables entered at step 1: male sex, local infiltration anaesthesia (LIA), general anaesthesia (GA). Exp (B): regression coefficient; CI: confidence interval.

3.3 Neuropathic Pain

Neuropathic pain assessment revealed significant disparities between the high-risk and low-risk groups postoperatively. The high-risk group exhibited notably worse DN4 and FSQ scores 1 day and 6 weeks after the operation, with significant discrepancies persisting in DN4 outcomes after 6 weeks. Logistic regression, adjusted for age, gender and BMI, yielded no significant results. Postoperative outcomes at 6 months demonstrated significant enhancements in various SF-36 subscales, WOMAC and NRS scores for both groups. However, no further significant differences were observed in other SF-36 subscales or ROM. A pairwise comparison revealed consistent improvements in NRS subscales after 3 and 6 months (Table 7). Significant disparities between the low-risk and high-risk groups were observed in pain and stiffness scores after 3 and 6 months, with no significant difference between the two time points. Additionally, no further significant differences were noted in other WOMAC subscales or SF-36 scores (Table 7).

		Group I (High Risk)			Group II (Low Risk)			p-Value	Effect Size	p-Value	Effect Size
		n = 20			n= 30			(Within Subject)	(η^2)	(Interaction Effect)	(η^2)
		Preoperative	3 Months	6 Months	Preoperative	3 Months	6 Months				
SF-36 (mean ± SD)	Physical function	32.1 ± 17.7	60.5 ± 21.7	67.0 ± 19.5	46.5 ± 28.3	56.1 ± 21.5	66.1 ± 18.0	**<0.001**	0.373	0.076	0.085
	Role physical	15.3 ± 27.0	32.9 ± 31.6	52.9 ± 37.4	29.2 ± 32.8	47.5 ± 32.7	59.4 ± 37.5	**<0.001**	0.249	0.796	0.006

	Role emotional	50 ± 45.5	60.4 ± 42.5	64.6 ± 46.3	72.2 ± 38.9	81.9 ± 32.6	77.8 ± 30.6	0.294	0.032	0.793	0.006
	Energy/fatigue	42.1 ± 19.5	52.6 ± 16.7	59.4 ± 20.7	58.8 ± 22.6	66.5 ± 15.3	61.9 ± 19.0	**0.011**	0.119	0.108	0.057
	Emotional well-being	62.4 ± 21.4	70.6 ± 19.7	70.8 ± 19.6	79.2 ± 17.1	79.8 ± 13.1	76.7 ± 18.8	0.24	0.07	0.115	0.054
	Social functioning	69.1 ± 31.3	86.8 ± 15.0	91.2 ± 15.8	90.1 ± 70.7	89.1 ± 13.9	84.4 ± 19.9	0.414	0.019	0.208	0.041
	Pain	34.7 ± 22.3	59.0 ± 15.9	61.0 ± 18.9	36.1 ± 20.1	67.3 ± 17.8	69.5 ± 20.3	**<0.001**	0.526	0.62	0.011
	General health	57.0 ± 18.5	62.9 ± 19.0	62.1 ± 19.9	66.3 ± 17.6	71.8 ± 16.0	67.3 ± 19.2	0.102	0.057	0.707	0.009
WOMAC (mean ± SD)	Total	41.9 ± 17.0	12.9 ± 10.4	14.8 ± 11.5	40.5 ± 20.3	17.7 ± 14.6	18.2 ± 14.6	**<0.001**	0.508	0.522	0.06
	Pain	48.4 ± 18.5	11.9 ± 10.6	13.5 ± 13.3	35.0 ± 18.3	12.5 ± 11.0	15.1 ± 16.3	**<0.001**	0.588	**0.029**	0.061
	Stiffness	58.3 ± 25.8	19.0 ± 17.1	19.0 ± 18.3	34.3 ± 23.4	23.5 ± 21.0	27.2 ± 20.7	**<0.001**	0.302	**0.002**	0.191
	Activity	41.2 ± 16.8	12.5 ± 10.6	14.8 ± 12.4	40.7 ± 22.4	18.4 ± 17.5	18.0 ± 15.0	**<0.001**	0.46	0.587	0.55
	Maximum	6.9 ± 2.1	3.5 ± 1.5	3.7 ± 2.5	6.2 ± 2.0	2.6 ± 2.4	2.2 ± 2.4	**<0.001**	0.53	0.592	0.013
NRS (mean ± SD)	Rest	2.5 ± 2.6	1.5 ± 1.1	0.7 ± 1.1	2.0 ± 2.0	0.8 ± 1.3	0.9 ± 1.8	**0.001**	0.184	0.451	0.264
	Activity	4.7 ± 2.4	2.3 ± 1.4	2.6 ± 1.7	4.6 ± 2.4	2.5 ± 2.4	2.3 ± 2.1	**<0.001**	0.308	0.744	0.001
ROM (mean ± SD)		111.8 ± 18.8	108.0 ± 11.5	110.6 ± 14.3	103.8 ± 16.6	96.7 ± 24.6	105.0 ± 19.4	0.183	0.043	0.691	0.021

SD: standard deviation; *SF-36*: Short Form 36; *WOMAC*: Western Ontario and McMaster Universities Osteoarthritis Index; *NRS*: Numeric Rating Scale; ROM: range of motion. Bold values indicate significant *p*-values.

Table 7: Results of repeated measures analysis of variance (ANOVA) for SF-36, WOMAC, NRS and ROM questionnaires to compare the results between the high-risk group (Group I) and the low-risk group (Group II). Reproduced with permission of publisher.

4. Discussion

4.1 Volatility, Uncertainty, Complexity and Ambiguity

The multimodal therapy concept is applied as soon as a patient presents themselves at an outpatient clinic. The consultation and treatment may expose the patient to a wide range of feelings and emotions. In this study we focused on the four VUCA factors of volatility, uncertainty, complexity and ambiguity, investigating their potential influence on orthopaedic patients (53).

The first topic that we investigated was how VUCA influences orthopaedic patients and how the VUCA factors alter patient expectations about communication with their physicians. The mean score for the VUCA factor of volatility on the AAQ-II questionnaire was 18 (SD: 10.0), indicating that the patients in our research group exhibited normal levels of volatility compared with the general population (88).

A mean score of 29 (SD: 8.7) was obtained for uncertainty on IUS-12 for the population being studied. Wilson et al. determined that a score of 28 was the threshold for GAD. Thus, the patients in our study had levels of uncertainty consistent with those of people suffering from GAD (89). The overall feeling of uncertainty experienced by individuals when seeking medical assistance may have been the reason for this result. To determine whether orthopaedic patients experience a greater degree of uncertainty when they see primary health providers, it is necessary to conduct interviews with patients from other departments.

For complexity, scores on 16-NCC of 16–32 are low, whereas those of 80–96 are considered to be high (118). The mean score on 16-NCC for the group in this study was 55 (SD: 13.0), indicating a moderate need for complex reasoning. This test was performed before the patients met the doctor and not during therapy.

A typical score on IOA, used to analyse the VUCA factor of ambiguity, was between 44 and 48 for a study population from the United States (51). The mean score for the orthopaedic patients treated at our UCC and OPD was 65 (SD: 8.0), indicating that they had a greater intolerance for ambiguity than the avarage Western population. For comparison, the mean scores of medical students ranged from 49 to 54 depending on their educational level (119, 120).

The purpose of our second research question was to establish whether there were differences in the level of satisfaction that patients experienced with the UCC and the

ODP. AAQ-II, which was used to analyse the VUCA factor of volatility, revealed that patients in the OPD had significantly higher scores than those in the UCC, with means of 20 (SD: 10.0) and 17 (SD: 9.0), respectively, as indicated by the p-value (t-test) of 0.006. The results on IUS-12 revealed a significant difference between the uncertainty of patients in the UCC (mean: 30, SD 8.9) and those in the OPD (mean: 28, SD: 8.3), with a p-value (t-test) of 0.032. Therefore, patients of the OPD exhibited greater levels of uncertainty during consultation. This result may have been because patients in non-acute departments endure pain or disease for extended durations. Patients in the OPD exhibited significantly greater levels of need for cognitive closure (mean: 58, SD: 12.0) than those in the tertiary care centre (UCC), who had a mean score of 52 (SD: 13.0), as demonstrated by a p-value (t-test) of 0.001. This could have been due to the prolonged duration of therapy as well as the contradictory therapeutic perspectives held by orthopaedists, who are private practitioners and clinical physicians. We identified a difference between the two departments in the VUCA factor of ambiguity, evaluated by IOA. Patients from the UCC had a mean score of 67 (SD: 7.2), greater than that of 63 (SD: 8.4) for patients from the ODP. Thus, the patients treated in the UCC exhibited a greater degree of ambiguity than those treated in the OPD, as indicated by a p-value (t-test) of 0.002. Regarding the overall satisfaction of each VUCA solution, the UCC achieved better outcomes than the OPD. This result might be explained by the fact that trauma departments, such as the UCC, can provide prompt care for acute conditions. Because patients frequently attend the OPD after experiencing pain and limitations in function for an extended duration, the monotony of suffering from non-acute orthopaedic disorders may be perceived as a challenge in terms of satisfying patient needs.

In line with the biopsychosocial model, it is hypothesized that integrating the VUCA tool into the communication repertoire of physicians will significantly improve patient satisfaction during doctor–patient consultations. The multimodal therapy concept is applied upon a patient's arrival at an outpatient clinic, where consultations and treatments may evoke various emotions. This study focuses on the VUCA factors of volatility, uncertainty, complexity, and ambiguity and their potential impact on orthopaedic patients. Initial investigation reveals that patients exhibit normal levels of volatility and uncertainty, consistent with general population norms, but experience

moderate levels of complexity and a greater intolerance for ambiguity. Patients in the outpatient department (OPD) show significantly higher scores for volatility and uncertainty compared to those in the urgent care center (UCC), potentially due to prolonged therapy and conflicting therapeutic perspectives. Moreover, patients treated in the UCC demonstrate a higher degree of ambiguity than those in the OPD, correlating with better overall satisfaction in the UCC, likely attributed to its prompt care for acute conditions compared to the chronic nature of orthopaedic disorders seen in the OPD.

4.2 Local Dexmedetomidine Infiltration

This study is the first to provide data on the effect of combining LIA and dexmedetomidine in orthopaedic treatment on opioid consumption by patients.

The significantly lower opioid requirement in the USRA group within the first 48 postoperative hours indicates better pain control after the operation and may be regarded as the most important result of this study.

Even though the opioid consumption of the LIA group (42 mg OME, equivalent to 14 mg morphine in 48 hours) was significantly higher than that of the comparison group, lower opioid consumption was observed than that in the studies included in a recent review (121).

The difference between the two procedures (LIA vs. USRA) was also reflected in the postoperative NRS score, which was lower from immediately in the PACU to 48 hours postoperatively.

These results contradict those of three older studies, which found that LIA had the same postoperative potency as USRA (122-124). One of the older studies included 166 patients in a randomised trial and found that LIA achieved similar pain reduction to USRA (femoral nerve block and single-shot sciatic nerve block) (123). It also found that patients in the LIA group exhibited higher OME consumption postoperatively and that, at subsequent follow-up, patients treated with USRA had a higher rate of nerve lesions (123).

Another of the three studies revealed that, in addition to postoperative pain reduction (in this case, a popliteal nerve block was also performed), there was a reduction in

OME, with the only difference between the LIA and USRA groups being in the duration of the anaesthesia procedure (122).

The third study, which had a retrospective cohort design and included 206 people, indicated no differences between the LIA and USRA groups, where USRA involved a combination of femoral and popliteal blocks (124).

The studies mentioned so far, described by Kastelik et al. (122), reported higher postoperative OME values overall, but lower NRS values.

Thus, considering the recent literature, one can conclude a beneficial effect from the joint use of ropivacaine and dexmedetomidine.

Since this study was rejected by the local ethics committee in its initial planning, namely, it was considered unethical to not provide the LIA group with dexmedetomidine, one can only make assumptions about the improvement of the LIA procedure through the combination with dexmedetomidine. This limitation of the study design, namely the lack of an LIA group without dexmedetomidine, or a comparison of the effects of dexmedetomidine and ketorolac, and the fact that the study was conducted at a single centre, complicates the interpretation of the results. For this reason, to compare the effect of LIA with or without dexmedetomidine, it was only possible to make a comparison with other studies.

We consider that this study reveals that more efficient pain control in the postoperative setting, in terms of duration and intensity, was achieved when the USRA method was used. Nevertheless, some studies recommend LIA over USRA, because the femoral blocks in USRA and the procedure itself result in motor function impairment (66).

The focus of this study was OME consumption measured postoperatively and the resulting reduction in NRS values. In terms of time, only the intervention time of the entire procedure was measured and not the duration required for LIA or USRA.

Various studies have also reported that the USRA procedure is much more time-consuming than the LIA technique, resulting in fewer possible TKAs per day of surgery (71, 122, 125-127). The LIA technique also appears to have a lower cost (71).

In Austria’s national healthcare system, the length of stay (LOS) after TKA has long been compared with that of international healthcare systems due to local logistics.

The objective of the follow-up was the same as in our previous study, in which LIA was compared with USRA using the drug ropivacaine with the addition of dexmedetomidine during TKA implantation. The key result of the previous study was that the subjects treated with LIA reported a significantly higher level of well-being than those treated with USRA. This is particularly noteworthy, as the subjects in the LIA group exhibited higher opioid consumption (1).

In the present study, although a higher level of well-being was observed in the patient group treated with LIA than in the group treated with USRA after 6 weeks, no differences between the groups were observed after 2 years. This finding also applies to the parameters of clinical results and pain. Thus, it is possible that the nervous blocks used in USRA and the associated higher opioid requirement have a major influence on well-being in the early period.

Well-being can only be assessed subjectively (128). It is already known that well-being generally results in higher patient satisfaction after TKA placement (129) and that the psychological attributes of depression, dysfunctional coping and pessimism result in worse outcomes after TKA implantation (130). This strong evidence supports our interpretation that psychological and physical effects have a strong impact on well-being.

Compared with the patients in a study by Kampitak et al. (131), in which LIA was compared with adductor blocks, the patients in our LIA group exhibited a higher level of well-being. In the study of Kampitak et al. (130), the patients treated with LIA exhibited a lower level of well-being than that of the control group (no statistical significance). Furthermore, our results differ from those in the study by Kastelik et al. (122) in terms of patient satisfaction and postoperative opioid consumption.

In contrast, Uesugi et al. (132) observed no significant difference in satisfaction 48 hours after LIA with a combination of a sciatic nerve block (SNB) and a femoral nerve block (FNB).

In this study, we demonstrated for the first time that patients in the LIA group had significantly higher pain scores on day 5 than those in the USRA group but also reported a higher level of well-being. Furthermore, we revealed that well-being can be seen as a motivating factor (133) that has a positive effect on rehabilitation and thus leads to better knee health.

This aspect is particularly relevant to early mobilisation, as it clearly supports functional outcomes (134-136), and LIA also supports recovery and pain control (137-139). The postoperative short-term functional outcomes in our study are consistent with those of past studies, in which TKA implantation was performed under LIA and USRA, and no significant differences were observed in patient outcomes (140, 141). Fan et al. (141) examined the endpoint of the CPSP function score, and we were also unable to find any significant differences for this score. Our results are also consistent with those of Li et al. (140), who observed no statistical significance for results regarding short-term functionality. All these studies indicate that USRA and LIA favour short-term functional recovery.

However, Yu et al. (133) detected significantly more falls in the USRA group than in the LIA group in the inpatient setting. Falls can lead to anxiety in patients and have a negative impact on the rehabilitation process (142, 143). A more recent study compared the effect of adding dexmedetomidine to ropivacaine in LIA and USRA and revealed a superior opioid-sparing effect in both groups. However, USRA was superior to LIA in a direct comparison (1).

The better results for LIA than for USRA in pain therapy in the early phase after TKA, thus having a positive influence on rehabilitation and patient satisfaction, are also supported by another study (139). In addition, Aso et al. (144) demonstrated that LIA combined with an FNB is suitable for postoperative pain therapy. Lychagin et al. (145) found that USRA had a significantly better effect on pain therapy than LIA only in the first 4 hours after the operation. This effect was not observed in our patients in the LIA group, who reported significantly more pain 5 days after TKA. The greatest possible satisfaction among patients has so far been observed for a USRA–LIA combination (146).

Various studies have found that the use of LIA with bupivacaine together with a femoral block increased the number of patients who could be mobilised on the day of the procedure, resulting in better recovery in general and improved functionality, but the pain values were very similar in the groups (133, 138, 144, 147). In addition, Surdam et al. (148) reported that the average hospitalisation LOS is also reduced when LIA is used. A similar reduction in the hospitalisation LOS was reported by

Spangehl et al. (123), although they found that LIA has equivalent pain relief to the SNB and FNB combination.

In general, however, the current literature regarding functional outcome, postoperative pain, hospitalisation time, patient satisfaction and opioid consumption does not yet allow a definitive statement to be made regarding the optimum, as studies have yielded different results (2, 131, 133, 138, 139, 148, 149). This variation makes it difficult to clearly conclude whether USRA or LIA is superior in the clinical context of TKA placement. Since the patients must be considered individually, it is important to state that the decision for or against a particular method should always be made on a case-by-case basis and involve with interaction with the patient and the consideration of their needs, wishes and previous illnesses, as well as their risk profile.

In this study, we demonstrated that to improve the results for individuals, the decision of LIA or USRA should depend on the desired effect, such as analgesia (USRA) or motor function (LIA).

In addition to investigating potential differences in satisfaction between patients receiving ultrasound-guided nerve blocks in the Urgent Care Center (UCC) and those undergoing Local Infiltration Analgesia (LIA) in the Outpatient Department (OPD), it is hypothesized that patients undergoing ultrasound-guided nerve blocks will report higher levels of satisfaction due to differences in postoperative pain control. This study contributes novel data on the combined effect of LIA and dexmedetomidine in orthopaedic treatment on opioid consumption by patients. The significantly lower opioid requirement in the Ultrasound-guided Regional Anesthesia (USRA) group within the first 48 postoperative hours suggests superior pain control post-operation, which is a significant finding. Although opioid consumption in the LIA group was higher compared to the comparison group, it remained lower than that reported in recent reviews. Furthermore, the difference in postoperative pain scores between the two procedures underscores the potential advantages of ultrasound-guided nerve blocks. However, contrasting results from older studies suggest similar pain reduction between LIA and USRA, indicating the need for further investigation. This study's limitation, namely the lack of an LIA group without dexmedetomidine, complicates result interpretation, emphasizing the need for cautious consideration of these

findings. Ultimately, individual patient needs and preferences should guide the choice between LIA and USRA, considering their differing effects on analgesia and motor function.

4.3 Neuropathic Pain

In this study, we analysed the impact of known risk factors on TKA outcomes. Both high-risk and low-risk groups exhibited satisfactory results initially, but high-risk patients experienced worse outcomes for pain, functional ability and quality of life, with a stronger neuropathic pain component. However, these differences decreased over time, with the high-risk group obtaining better values for pain and stiffness at the final 6-month follow-up. Preoperative yellow flags contributed to a challenging early postoperative phase (150). Gender differences were significant, with more women in the high-risk group, likely due to their higher susceptibility to pain and depression (151-153). High-risk patients consistently obtained worse values in depression, anxiety and neuropathic pain assessments. We obtained conflicting for the role of pain catastrophising and neuropathic pain in chronic pain after surgery, emphasising the need for further research. High-risk patients exhibited higher DN4 scores, consistent with other studies (154). Both groups showed significant improvements in clinical outcomes and quality of life, contrary to expectations, with the high-risk group obtaining lower pain and stiffness scores. This suggests that broader factors beyond knee-specific issues influence pain perception. Long-term assessments are essential due to the variability in the influence of preoperative neuropathic pain and depressive disorders on TKA outcomes over time.

In this study, we investigated the impact of preoperative risk factors on total knee arthroplasty (TKA) outcomes, aiming to identify opportunities for tailored interventions to mitigate chronic postsurgical pain (CPSP). Our analysis revealed that both high-risk and low-risk patient groups initially achieved satisfactory results postoperatively. However, high-risk patients consistently reported worse outcomes for pain, functional ability, and quality of life, often characterized by a stronger neuropathic pain component. Notably, these differences in outcomes tended to diminish over time, with the high-risk group showing improvements in pain and stiffness at the final 6-month follow-up. Preoperative identification of yellow flags contributed to the

challenges observed during the early postoperative phase. Gender disparities were evident, with a higher proportion of women in the high-risk group, likely reflecting their increased susceptibility to pain and depression. High-risk patients consistently exhibited worse scores in depression, anxiety, and neuropathic pain assessments. However, our findings regarding the roles of pain catastrophizing and neuropathic pain in chronic postsurgical pain were conflicting, underscoring the need for further investigation in this area. High-risk patients also demonstrated higher DN4 scores, consistent with findings from previous studies. Despite these challenges, both high-risk and low-risk groups showed significant improvements in clinical outcomes and quality of life. Surprisingly, the high-risk group obtained lower pain and stiffness scores over time, suggesting that broader factors beyond knee-specific issues may influence pain perception post-TKA. Long-term assessments are crucial due to the variability in the influence of preoperative neuropathic pain and depressive disorders on TKA outcomes over time, highlighting the importance of tailored interventions and multidisciplinary approaches to address CPSP effectively.

4.4 Strengths and Limitations

A strength of this study is that it provides a comprehensive analysis of the VUCA factors (volatility, uncertainty, complexity and ambiguity) and their possible impact on orthopaedic patients. To quantify the volatility and uncertainty, we used AAQ-II and IUS-12, which generated quantifiable data, thus providing a better understanding of the impact of the VUCA factors on patients. In addition, we compared results between patients in different departments, namely, the UCC and OPD, thus providing additional insight into the disparities between the different treatment contexts. The study also reveals possible correlations between the VUCA factors and patient satisfaction with their care environment. Using statistical analyses such as the t-test, we determined whether there were significant differences between the groups, enabling us to obtain relevant findings. These findings make a significant contribution to the in-depth comprehension of the intricate psychological and emotional components of orthopaedic treatment.

The length of the questionnaires was the most limiting aspect in our experiment, reducing the willingness of the patients to complete them. A further limitation of our experiment was the absence of data from the questionnaires filled out by each participant. Using REDCap®, we attempted to minimise the quantity of missing data by flagging and notifying staff when data was missing. Additionally, the execution of the satisfaction survey acted as a barrier, since it had to be completed immediately prior to the patients leaving our department. Because many patients were unwilling to remain in the department and engage with our team after they had received therapy, this endeavour was unsuccessful. A second attempt to obtain information via an internet poll, which patients could complete at home, significantly increased the number of responses. Nevertheless, some data was still lacking, which we obtained by phoning each patient.
Another limitation of this study is that the recruiting process was only carried out in two of the departments that make up the OPD. To obtain a more comprehensive understanding of VUCA factors in relation to orthopaedic patients, our experiment could be performed at more clinics.

Regarding the use of LIA in conjunction with dexmedetomidine, the findings of this study are the first of their kind to be presented. In the first 48 hours following surgery, the USRA group required a significantly lower amount of opioids than the LIA group. This is the most significant conclusion of the current study. The results of this study indicate that the patients in the USRA group experienced higher levels of early postoperative pain control after undergoing primary TKA surgical measures.

It is important to highlight that the design of this analysis, which consisted of a single centre and the absence of control groups that did not receive dexmedetomidine, makes it difficult to evaluate the data. This is one of the drawbacks of this inquiry. Furthermore, the primary technique of anaesthesia (general anaesthesia versus spinal anaesthesia) varied among the patients; however, according to the results of the logistic regression analysis, this difference did not appear to have any effect on the outcomes. In addition, ketorolac was intentionally not administered to make it

easier to directly examine the effect of dexmedetomidine. Furthermore, in accordance with the judgement of the main surgeon, a considerable quantity of ropivacaine was injected for LIA. Note that the LOS following TKA in Austria is much longer than in other countries due to the presence of several logistical variables within the local healthcare system. In future research, it will be essential to take into consideration the anaesthetic technique (either spinal or general anaesthesia) during the design phase to minimise the potential bias generated by a major difference. In this study, anaesthesia specialists carried out the majority of USRA procedures, and when a trainee was responsible for administering the block, a specialist was present to supervise and observe the trainee. According to the literature, dexmedetomidine can now be included in local anaesthetics. The use of a control group that did not receive dexmedetomidine was not permitted in this study because of ethical limitations. Therefore, we were only able to compare the effectiveness of LIA without the use of dexmedetomidine with the results of earlier studies that included the use of dexmedetomidine.

In the case of neuropathic pain, the subjective classification of patients into high-risk and low-risk groups, in addition to the subjective experience of pain itself, introduces additional potential for bias and subjectivity, increasing the difficulty of making comparisons with past research. Furthermore, the absence of a control group in our study made it difficult to directly compare the outcomes of patients who did not receive TKA with those of the high-risk and low-risk groups using the same individuals. To determine the influence of yellow flags on the outcomes of TKA, a control group would have been an extremely helpful reference point.

4.5 Conclusion

The concept for integrating VUCA factors into clinical practice to improve patient satisfaction aims to enhance patient satisfaction in orthopedic and traumatological care by incorporating the VUCA tool (Volatility, Uncertainty,Complexity, Ambiguity) into physician-patient communication. Thebiopsychosocial model is considered to address the physical, psychological, and social aspects of the patient experience. Research has shown that patients exhibit normal levels of volatility and uncertainty, moderate complexity, and high ambiguity. Patients in the outpatient department (OPD) show higher levels of volatility and uncertainty than those in the urgent care center (UCC), while patients in the UCC experience higher ambiguity and satisfaction due to the quicker treatment of acute conditions. Implementation involves training physicians in dealing with VUCA factors to increase their sensitivity and competence. This includes communication techniques, stress management, and empathy training through workshops, role-playing, and case studies. To reduce uncertainty and ambiguity during consultations, clear explanations, open communication, and patient involvement in decision-making are implemented. A multimodal therapy approach ensures holistic patient care by considering their emotional and social needs through interdisciplinary teams, individual therapy plans, and regular case discussions. Patient education and involvement aim to increase patient autonomy and satisfaction by providing better information and involving them in the treatment process through informational materials, health literacy workshops, and digital information platforms. Evaluation and continuous improvement of the measures are ensured through regular patient surveys, feedback mechanisms, and data collection and analysis. Implementation occurs in three phases: preparation through needs assessment and development of training programs, implementation through training and introduction of new communication protocols and therapy approaches, and evaluation through regular review of measures and adjustment of strategies based on evaluation results.

This study revealed that substantial breakthroughs have been made in the field of LIA. During TKA, the use of dexmedetomidine in conjunction with the local anaesthetic in USRA significantly reduced patient, in addition to a reduction in the amount of opioids administered. Furthermore, our data suggests that LIA also has a

sustained impact on reducing opioid use, which is greater than that reported in recent studies. The possibility for improving pain management regimens through the use of adjuvant treatments such as dexmedetomidine highlights the need for additional investigation into the ideal doses of prescription medications.

In this study, several noteworthy dynamics between LIA and USRA beneficiaries were revealed by follow-up examinations. Patients treated with LIA reported considerably greater pain levels than their counterparts treated with USRA, despite the LIA-treated patients displaying improved well-being and equivalent early postoperative functional results. This juxtaposition suggests the potential benefit of LIA in enabling rapid healing and generating the desire for physiotherapy and rehabilitation, which can be ascribed to its enhancement of short-term well-being.

The findings of this study highlight the complexity of preoperative patient evaluation in the context of neuropathic pain and its effect on the outcomes of TKA. In the early postoperative phase, factors such as neuropathic pain and accompanying yellow flags, which are indicators of psychological distress, were revealed to be key variables that influenced the outcomes. During the first few weeks after surgery, patients who exhibited these signs were confronted with significant difficulties, including reduced health-related quality of life, increased level of discomfort, and better functional results. It is particularly noteworthy that our findings underline the significance of individualised treatments, since high-risk individuals demonstrated significant improvements in joint-specific outcomes after intervention. This indicates the need for individualised therapeutic approaches and for more research to improve prognostic markers, such as yellow flags, and to optimise patient selection criteria, thus maximising the advantages of TKA for all patients.

The studies at hand align seamlessly with a multimodal treatment approach for orthopaedic and traumatological patients as they cover various aspects of treatment and provide crucial insights into the patient experience. The examination of VUCA factors (Volatility, Uncertainty, Complexity, and Ambiguity) illustrates that orthopaedic and traumatological patients undergo a range of emotions and challenges during

their treatment. These factors can influence patients' expectations regarding communication with physicians, highlighting the importance of a holistic treatment approach that addresses not only physical complaints but also psychological and emotional needs.

Moreover, the study on local dexmedetomidine infiltration offers important insights into postoperative pain control in orthopaedic and traumatological procedures, demonstrating that combining local anesthetics with dexmedetomidine can significantly reduce opioid consumption. These findings support the concept of a comprehensive treatment approach that targets not only immediate pain relief but also considers long-term effects and potential complications.

Furthermore, the investigation into neuropathic pain sheds light on the significance of preoperative risk factors for total knee arthroplasty outcomes in orthopaedic and traumatological patients. It underscores the need to develop individualized interventions to prevent or minimize chronic post-surgical pain. The results indicate that a comprehensive assessment of preoperative factors, including psychological and neuropathic pain components, is crucial for optimizing the treatment of orthopaedic and traumatological patients and improving their long-term quality of life.

Overall, these various studies contribute to a comprehensive understanding of the needs and challenges faced by orthopaedic and traumatological patients and underscore the importance of a multimodal treatment approach that considers various aspects of patient care to achieve optimal outcomes.

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