

OPTIMIZING OUTCOMES IN UNDISPLACED FEMORAL NECK FRACTURES AMONG ELDERLY PATIENTS: A NARRATIVE REVIEW.

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Page | 1 **ABSTRACT**

Femoral neck fractures (FNF) in the elderly represent a formidable clinical challenge, often resulting from low-energy incidents such as falls. The increasing incidence of osteoporosis and other age-related diseases that negatively impact treatment outcomes adds to the complexity of addressing these injuries. The particular concern with undisplaced fractures lies in achieving fracture healing while minimizing the risk of complications such as non-union and avascular necrosis. The review aims to synthesize current evidence on the treatment modalities for undisplaced FNFs in elderly patients, focusing on optimizing union rates and minimalizing the risk of avascular necrosis, to guide clinical practice and policy development. The comprehensive review highlights the crucial role of early, tailored surgical intervention in promoting fracture healing. Internal fixation remains the ideal treatment for non-displaced fractures in patients with good bone healing potential, whereas hemiarthroplasty and total hip arthroplasty are favored in cases with a high risk of avascular necrosis or patients with pre-existing hip pathology. The significance of early postoperative rehabilitation and a multidisciplinary approach to care in enhancing recovery and functional outcomes is also emphasized. The insights gained underscore the need for further research into surgical innovations and rehabilitation strategies to improve outcomes for this vulnerable population. Future studies should aim at refining surgical techniques to reduce the incidence of complications and at developing comprehensive, patient-centered care plans. The findings advocate for the integration of multidisciplinary care pathways and personalized treatment plans in clinical policies to address the holistic needs of older patients with undisplaced FNFs. Such policies should emphasize the importance of rapid surgical intervention, where appropriate, and the early initiation of rehabilitation programs.

Keywords: Femoral neck fractures, Elderly, Union rates, Avascular necrosis.

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INTRODUCTION

Femoral neck fractures (FNF) in the elderly represent a significant clinical challenge due to the population's unique physiological and comorbid conditions. These fractures are particularly prevalent among individuals over the age of 65, often resulting from low-energy mechanisms such as falls from a standing height. The management of these injuries is complicated by factors including osteoporosis, reduced bone quality, and the presence of other age-related health issues, which can significantly affect treatment outcomes and patient prognosis.

The challenge of treating undisplaced FNFs lies in the balance between preserving the femoral head and ensuring the stability of the fracture for bone healing. Unlike displaced fractures, which often require surgical intervention to realign the bone fragments, undisplaced fractures do not show obvious misalignment on radiographic imaging. However, the risk of non-union and avascular necrosis (AVN) remains a concern. The decision-making process involves considering the patient's overall health status, the potential for fracture displacement, and the risk of complications associated with both conservative and surgical treatment options.

Focusing on union rates and AVN is crucial in the treatment of FNFs in the elderly. Union rates are a primary measure of fracture healing and significantly impact

patient mobility and quality of life post-injury. A successful union is often defined by the absence of pain in the groin area on weight-bearing and the radiological evidence of fracture healing. However, AVN is a dangerous side effect that can require a total hip replacement due to the disruption of the blood supply to the femoral head, which can end in bone death. The degree of initial fracture displacement, the precision of fracture reduction, and the fixation technique employed during surgical therapy all affect the incidence of AVN [1].

Given these considerations, the management of undisplaced FNFs in the elderly requires a comprehensive approach that weighs the risks and benefits of different treatment modalities. The ultimate goal is to achieve fracture healing (union) while minimizing the risk of AVN, thereby preserving the patient's mobility and independence. Research and clinical practice continue to evolve, with ongoing studies aimed at refining treatment protocols to improve outcomes for this vulnerable population group.

The review explores the treatment of undisplaced FNFs in elderly patients, aiming to identify optimal strategies for improving outcomes. It critically evaluates current treatment modalities, including surgical and non-surgical approaches, their impact on union rates and avascular necrosis risk, and the role of rehabilitation and multidisciplinary care in enhancing recovery. By

addressing key questions on the effectiveness and safety of these treatments, variations in critical outcomes across different interventions, and the importance of postoperative care, the review seeks to inform clinical practice and policy development. The goal is to guide healthcare professionals in selecting the most appropriate treatment strategies that not only mitigate complications but also promote functional recovery and improve the quality of life for this vulnerable population group.

METHODOLOGY

Search Strategy

A systematic literature search was carried out across multiple electronic databases including PubMed, Embase, Web of Science, and the Cochrane Library, focusing on articles published in English between 2000 and 2023. Keywords such as "undisplaced femoral neck fractures," "elderly," "treatment outcomes," "surgical techniques," "union rates," and "avascular necrosis" were utilized. The search was augmented by manual searches of reference lists from relevant articles to ensure comprehensiveness.

Inclusion and Exclusion Criteria

Included studies were those published in peer-reviewed journals, focusing on the treatment of undisplaced FNFs in patients aged 65 and above, and reporting on outcomes such as union rates and incidence of avascular necrosis. Excluded were non-English articles, case reports, conference abstracts, and studies not directly addressing the treatment outcomes of interest.

Study Selection

Two reviewers independently conducted an initial screening of the titles and abstracts, and then they reviewed the entire texts of the chosen articles to ascertain eligibility according to the predetermined criteria. A third reviewer was consulted or included in the conversation to address disagreements.

Data Extraction and Synthesis

Data on study characteristics, participant demographics, treatment modalities, and outcomes were extracted using a standardized form. The synthesis focused on comparing treatment outcomes across different modalities, with a particular interest in surgical techniques, rehabilitation approaches, and their impact on union rates and avascular necrosis.

DISCUSSION

Epidemiology and Significance

The epidemiology of undisplaced FNFs in patients over 65 underscores a growing public health concern, given the aging global population. Studies indicate that these fractures are a common injury among the elderly, with incidence rates increasing significantly with age. This rise

is particularly notable in post-menopausal women, where osteoporosis plays a critical role in predisposing individuals to fractures even after low-energy trauma such as falls from standing height [2].

The impact of these fractures extends beyond the immediate injury, significantly affecting patients' mobility, independence, and overall quality of life. Elderly patients suffering from FNFs often experience a decline in their functional status, leading to increased dependency on others for daily activities. Reduced mobility is linked to an increased risk of consequences, including pressure ulcers, pulmonary embolisms, and deep vein thrombosis. Moreover, the psychological impact of reduced independence and fear of falling again can lead to social isolation and depression, further diminishing the quality of life.

From an economic perspective, the treatment and management of FNFs in the elderly impose substantial burdens on healthcare systems worldwide. The costs associated with surgical treatment, rehabilitation, and long-term care for patients who experience decreased mobility or become bedridden are significant. Additionally, the indirect costs resulting from lost productivity of caregivers and the patients themselves contribute to the economic strain. As the population ages, the incidence of FNFs and the associated healthcare costs are expected to rise, emphasizing the need for effective prevention strategies and efficient management protocols to mitigate these impacts [3].

Undisplaced FNFs in patients over 65 presents not only a clinical challenge but also a significant public health issue, with profound effects on the individuals' quality of life and independence, as well as considerable economic and healthcare system burdens. Addressing these fractures effectively requires a multidisciplinary approach that includes timely and appropriate medical intervention, rehabilitation, and measures to prevent osteoporosis and falls in the elderly population.

Pathophysiology

The pathophysiology of FNFs in the elderly, along with the factors that contribute to their occurrence and complications, such as non-union and AVN, is a complex interplay of biomechanical, biological, and environmental factors.

FNFs result from a disruption in the balance between bone resilience and mechanical forces applied to the hip. In the elderly, decreased bone mineral density (BMD) and changes in bone architecture, such as thinning of the cortical bone and reduction in trabecular bone volume and connectivity, contribute significantly to this imbalance. These changes, often a result of osteoporosis, increase the susceptibility of the femoral neck to fracture under relatively low-energy forces, such as those experienced during a fall from standing height [4].

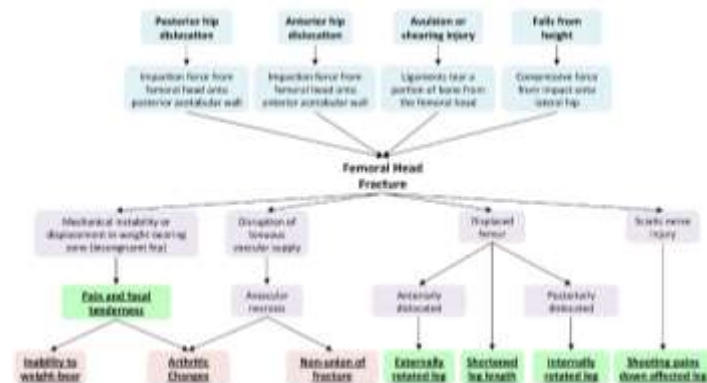


Figure 1: Pathogenesis and clinical findings of FNFs

Bone Quality in the Elderly and Risk Factors for Fracture

The deterioration of bone quality in the elderly is primarily attributed to aging and osteoporosis. Factors that accelerate bone loss include hormonal changes, particularly post-menopausal estrogen deficiency, inadequate intake or absorption of calcium and vitamin D, sedentary lifestyle, and the usage of certain medications like glucocorticoids. Furthermore, conditions such as rheumatoid arthritis and chronic renal failure also predispose individuals to osteoporosis and, consequently, to fractures.

Avascular necrosis and non-union after FNFs are associated with several risk variables that are connected to the initial injury and the care that follows. Important factors include the extent of displacement and interruption of the femoral head's blood supply at the moment of damage. The medial and lateral circumflex femoral arteries furnish the majority of the blood supply to the femoral head. These vessels may be damaged by a fracture, which could impair blood flow and increase the risk of avascular necrosis.

Non-union is often a consequence of inadequate or delayed surgical intervention, poor fracture reduction, or instability of the fracture fixation, which can prevent proper bone healing. Additional risk factors include

smoking, diabetes, and the use of nonsteroidal anti-inflammatory drugs (NSAIDs) post-injury, which can impair bone healing and blood supply restoration [5].

Given the significant impact of non-union and avascular necrosis on patient outcomes, understanding these risk factors is essential for guiding treatment decisions and preventive strategies aimed at reducing the incidence of these complications.

Diagnostic Approaches

The diagnostic process for FNFs, especially in the elderly, is crucial for determining the most appropriate treatment plan. This process includes both clinical assessment and diagnostic imaging, each playing a pivotal role in ensuring accurate diagnosis.

The initial clinical assessment of a patient suspected of having a femoral neck fracture typically involves a thorough history taking and physical examination. Clinicians assess for common symptoms such as pain in the hip or groin area, especially with weight-bearing movements, and a shortened and externally rotated leg. Risk factors, including a history of falls, osteoporosis, and previous fractures, are also considered. This clinical evaluation guides the need for further diagnostic imaging and helps rule out other conditions that may present with similar symptoms [6].

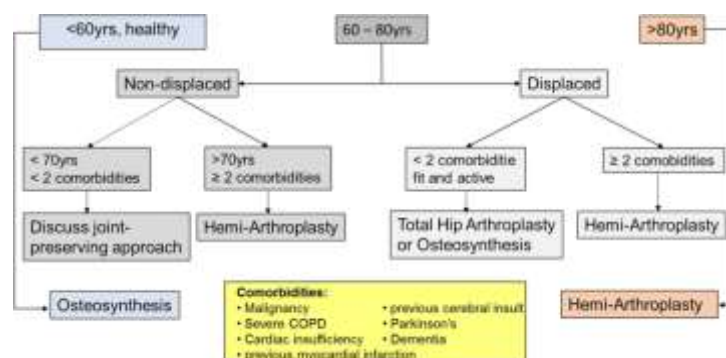


Figure 2: Treatment algorithm of FNFs

Diagnostic Imaging

Diagnostic imaging is indispensable for confirming the presence of an FNF and for characterizing the fracture's

type, location, and degree of displacement, which are crucial for planning treatment. The standard imaging modality is plain radiography, with anteroposterior (AP) and lateral views of the hip being essential for initial evaluation. However, if the plain radiographs are inconclusive but clinical suspicion remains high, more advanced imaging techniques such as magnetic resonance imaging (MRI) or computed tomography (CT) scans may be employed. MRI is particularly sensitive in detecting occult fractures not visible on plain radiographs and assessing vascular integrity, while CT scans can provide detailed information on the fracture geometry and are helpful in surgical planning [7].

An accurate diagnosis is fundamental to developing an effective treatment plan for femoral neck fractures. The specific details of the fracture identified through clinical and imaging assessments inform the decision-making process regarding the optimal treatment approach. For instance, the choice between conservative management, surgical fixation, or joint replacement largely depends on the fracture's characteristics such as its location, displacement, and the patient's overall health status and activity level. Misdiagnosis or underestimation of the fracture severity can lead to inadequate treatment, resulting in complications such as non-union, AVN, or prolonged disability.

Furthermore, an accurate diagnosis allows for better communication with patients and their families regarding the prognosis and expected outcomes, facilitating informed decision-making and consent for the proposed treatment options.

Treatment Modalities

FNFs can be treated with a variety of techniques, ranging from conservative therapy to several surgical alternatives, especially in the elderly. Several factors, including the patient's age, general health, bone quality, fracture details, and pre-injury functional level, influence the treatment plan.

Treatment strategies for FNFs aim to alleviate pain, restore function, and minimize complications such as non-union and AVN. The mainstay of treatment has traditionally been surgical, given the high incidence of complications associated with non-operative management in this fracture type. However, the specific surgical approach is tailored based on the fracture characteristics and patient factors [8].

Conservative Management

Conservative treatment may be considered in non-ambulatory patients, those with minimal displacement, or individuals with significant comorbidities that pose a high surgical risk. This approach typically involves pain management and restricted weight-bearing until the fracture shows signs of healing. Nevertheless, conservative management is less common due to the increased risk of complications such as prolonged immobility and the potential for fracture displacement [9].

Surgical Options

Internal fixation utilizes screws or pins for non-displaced or slightly displaced fractures, targeting patients with strong bone healing capabilities. This technique stabilizes the fracture to preserve the hip joint, facilitating early movement and weight-bearing. Hemiarthroplasty, replacing the femoral head with a prosthetic, suits displaced fractures or cases with a high avascular necrosis risk, especially for those who can't undergo a long non-weight-bearing phase or have inferior bone quality. Total hip arthroplasty (THA) replaces both the femoral head and acetabulum, ideal for patients with existing hip degeneration or unsatisfactory hemiarthroplasty outcomes. While THA tends to provide superior functional results and fewer repeat surgeries, it poses a greater risk of surgical complications [10].

Criteria for Selecting Treatment Modalities

The selection of the most appropriate treatment modality for FNFs involves considering the patient's functional demands, life expectancy, fracture pattern, and potential for bone healing.

Key considerations include:

- **Age and activity level:** Younger, more active patients may benefit more from attempts at fracture fixation, while older, less active patients may achieve better outcomes with arthroplasty.
- **Fracture characteristics:** Non-displaced fractures are more amenable to fixation, while displaced fractures may require arthroplasty.
- **Bone quality:** Poor bone quality may necessitate replacement strategies rather than fixation.
- **Comorbid conditions:** The presence of comorbidities that affect bone healing or surgical risk may influence the choice of treatment.

Ultimately, the goal is to select a treatment approach that optimizes the balance between restoring hip function, minimizing complications, and accommodating the patient's overall health status and lifestyle needs.

Union Rates and Avascular Necrosis

Union rates and avascular necrosis (AVN) are critical factors in the prognosis of FNFs, especially in the elderly. These outcomes not only reflect the success of the chosen treatment modality but also have significant implications for the patient's recovery and quality of life.

Union rates refer to the percentage of fractures that successfully heal after treatment. A high union rate indicates effective fracture healing, allowing patients to return to their pre-injury level of function. Conversely, a low union rate suggests a higher occurrence of non-union, where the fracture fails to heal properly, leading to persistent pain, disability, and the need for further surgery. **Avascular necrosis** of the femoral head is a disorder in which the femoral head's blood supply is impaired, which results in the bone tissue dying. A severe consequence following a femoral neck fracture is AVN, which can lead

to hip joint arthritis, collapse of the femoral head, and substantial functional impairment. The clinical implications of AVN are profound, often necessitating

joint replacement surgery to restore mobility and alleviate pain.

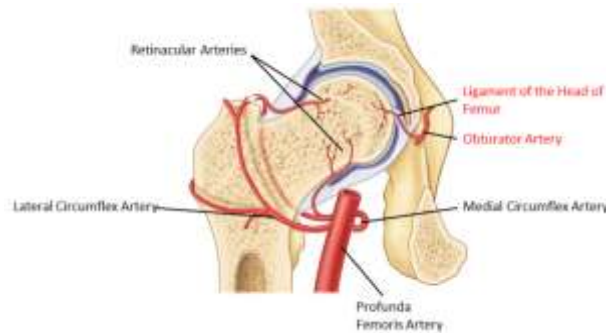


Figure 3: Avascular Necrosis of the Femoral Head (Hip Osteonecrosis)

Factors Influencing Union and Avascular Necrosis

The risk of non-union and AVN following undisplaced FNFs is influenced by several factors, including:

- ✓ **Fracture Displacement:** Even slight displacement can compromise the blood supply to the femoral head, increasing the risk of AVN.
- ✓ **Quality of Reduction and Fixation:** Accurate alignment and stable fixation are crucial for fracture healing. Inadequate reduction or fixation can lead to non-union or AVN.
- ✓ **Age and Bone Quality:** Older patients and those with poor bone quality (e.g., osteoporosis) are at higher risk for non-union and AVN due to impaired bone healing capacity.
- ✓ **Time to Surgery:** Delayed surgical intervention has been associated with increased rates of AVN, highlighting the importance of timely treatment [11].

Comparison of Treatment Outcomes

Treatment outcomes for undisplaced FNFs vary significantly between conservative management and surgical intervention. Surgical treatment, particularly internal fixation, is generally associated with higher union rates compared to conservative treatment. However, the risk of AVN remains a concern, particularly in cases where there is a disruption of the blood supply during surgery or due to the fracture itself.

Hemiarthroplasty and THA are surgical options that eliminate the risk of non-union and significantly reduce the risk of AVN by replacing the femoral head or both the femoral head and acetabulum, respectively. While these procedures offer reliable outcomes in terms of pain relief and function, they are associated with higher surgical risks and longer recovery times compared to internal fixation. The choice of treatment for undisplaced FNFs must carefully consider the risks of non-union and AVN. The selection of the appropriate treatment strategy should be tailored to each patient based on the risk factors present and the potential impact on their quality of life.

Surgical Techniques and Their Outcomes

The surgical management of FNFs involves a range of techniques, each with specific outcomes related to union rates and the risk of AVN. The choice of surgical option is determined by factors such as the type of fracture, patient's age, comorbidities, and pre-injury functional status.

Internal Fixation

Usually, sliding hip screws or cannulated screws are used for internal fixation. This approach is recommended for younger individuals or the elderly with a high propensity for bone healing who have non-displaced or mildly displaced fractures. As long as the femoral head's blood supply is preserved, the fundamental benefit of internal fixation is the patient's hip joint being preserved.

Hemiarthroplasty

Hemiarthroplasty involves the replacement of the femoral head with a prosthetic implant. It is indicated in displaced fractures, especially in elderly patients with lower functional demands. This procedure eliminates the risk of non-union and significantly reduces the risk of AVN by removing the femoral head. The choice between unipolar and bipolar prostheses depends on patient-specific factors and surgeon preference [12].

Total Hip Arthroplasty (THA)

THA involves replacing both the femoral head and the acetabulum with prosthetic components. It is considered for patients with pre-existing hip joint pathology or when hemiarthroplasty outcomes are deemed suboptimal. THA typically offers the best functional outcomes and satisfaction rates but carries a higher risk of complications and longer recovery times.

Techniques to Optimize Union Rates

To optimize union rates in internal fixation, precise surgical technique, and adequate fixation stability are crucial. The use of multiple parallel screws or a dynamic hip screw, placed in an inverted triangle configuration, can enhance the stability of the fixation and promote fracture healing. Additionally, minimally invasive techniques can help preserve the blood supply to the femoral head, further improving union rates [13].

Strategies to Minimize the Risk of Avascular Necrosis

Maintaining the blood supply to the femoral head throughout the whole course of treatment is essential to minimizing the risk of AVN. It is important to be cautious during surgical fixation to prevent damaging the blood vessels surrounding the femoral neck. To shorten the amount of time that the fracture would affect the blood flow, early surgical surgery is advised. For patients undergoing arthroplasty, meticulous surgical techniques to avoid damaging the remaining blood supply to the acetabulum and ensuring proper implant positioning are essential to prevent AVN of the adjacent bone [14].

The choice of surgical technique for FNFs significantly impacts outcomes such as union rates and the risk of AVN. Each surgical option has its advantages and indications, and the selection must be tailored to the individual patient. Continuous advancements in surgical techniques and implant design aim to further improve outcomes for patients with FNFs.

Rehabilitation and Post-operative Care

Rehabilitation and postoperative care are pivotal elements in the recovery process following surgical treatment for FNFs, especially in the elderly. These aspects of care aim to restore function, enhance mobility, and improve overall outcomes.

Rehabilitation plays a critical role in the recovery process, beginning as early as the immediate postoperative period. It includes a range of physical therapy interventions designed to strengthen muscles, improve balance, and increase joint mobility. An early start to rehabilitation, often within the first 24 to 48 hours post-surgery, has been shown to significantly improve outcomes, including reducing the risk of postoperative complications, such as deep vein thrombosis, and promoting a quicker return to pre-fracture functional levels. Tailored rehabilitation programs that progress from passive to active exercises can expedite the recovery process, enhancing patients' independence and quality of life [15].

Importance of Multidisciplinary Care in the Recovery Process

The complexity of managing FNFs in the elderly necessitates a multidisciplinary approach to care. This involves a team of healthcare professionals,

including orthopedic surgeons, physical and occupational therapists, geriatricians, nurses, and social workers, working collaboratively to address the comprehensive needs of the patient. Multidisciplinary care focuses not only on the physical aspects of recovery but also on nutritional support, pain management, and psychosocial support, ensuring a holistic approach to patient care.

Effective communication within the multidisciplinary team and with the patient and their family is crucial for coordinating care and setting realistic recovery goals. Involvement of geriatricians or specialists in geriatric medicine can be particularly beneficial in optimizing medical management, assessing for and treating comorbid conditions, and making recommendations for modifications in the home environment to prevent future falls and fractures. This collaborative approach has been associated with improved functional outcomes, reduced length of hospital stays, and decreased mortality rates [16].

Rehabilitation and multidisciplinary care are essential components of the postoperative management of femoral neck fractures, playing a vital role in improving patient outcomes. Early, individualized rehabilitation and a coordinated, holistic approach to care can significantly enhance the recovery process, promoting patients' return to their optimal level of function and independence.

CONCLUSION

The management of FNFs, particularly in the elderly, encompasses a broad spectrum of treatment modalities, each with distinct implications for patient outcomes. From internal fixation aimed at preserving the natural joint in minimally displaced fractures, to hemiarthroplasty and THA for more severe cases, the choice of surgical intervention is pivotal and must be tailored to the individual patient's clinical and functional profile. Critical to enhancing these outcomes is the early initiation of rehabilitation and the adoption of a multidisciplinary care approach, which together facilitate improved mobility, independence, and quality of life post-surgery. Advances in surgical techniques and postoperative care, alongside a deeper understanding of the factors influencing union rates and the risk of AVN, continue to refine patient management strategies. This review underscores the importance of a personalized, patient-centered approach to the treatment of femoral neck fractures, highlighting the need for ongoing research and innovation in surgical and rehabilitative care to optimize outcomes for this vulnerable population group.

Limitations

The review provides insights but is limited by its focus on specific patient groups, short follow-up periods, variability in treatment protocols, potential publication bias, and a lack of randomized controlled trials (RCTs) and comprehensive patient-centered outcomes. To improve the evidence base, future studies should standardize protocols, include diverse populations,

conduct longer-term follow-ups, emphasize patient-centered outcomes like functional recovery and quality of life, and incorporate recent innovations in surgical techniques, implants, and rehabilitation technologies.

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List of abbreviations

FNF: Femoral Neck Fracture
AVN: Avascular Necrosis
BMD: Bone Mineral Density
MRI: Magnetic Resonance Imaging
CT: Computed Tomography
THA: Total Hip Arthroplasty
NSAIDs: Nonsteroidal Anti-Inflammatory Drugs
RCTs: Randomized Controlled Trials

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Conflict of interest

The authors have no competing interests to declare.

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