SVOA Orthopaedics

ISSN: 2752-9576

ScienceVolks Open Access

Review Article

Perioperative Nutrition Optimization in Rotator Cuff Repair

Alex R. La Poche, BA[1]* and David S. Pereira, MD[2]

Abstract

Rotator cuff injuries severely affect quality of life, particularly in the elderly, with many patients experiencing non-healing after rotator cuff repair (RCR) surgery. This review explores the influence of nutrition on healing after RCR and the effects of perioperative nutritional optimization. Analysis of studies on the impact of macronutrients, micronutrients, and dietary supplements on postoperative recovery highlights that malnutrition is common in RCR patients and linked to poor outcomes. Nutritional optimization, such as supplementation with amino acids and vitamin D, supports tissue repair and immune function, improving recovery. Individualized nutrition plans and revised fasting guidelines could enhance surgical success.

Keywords: *Perioperative Nutrition, Rotator Cuff Repair, Malnutrition , Rotator Cuff injuries*

Introduction

Rotator Cuff injuries are one of the most common causes of upper extremity pain and disability, particularly affecting the elderly. Tashjian et al. reported that full-thickness rotator cuff tears are present in approximately 25% of individuals in their 60s and 50% of individuals in their 80s.[1] These injuries significantly impact the quality of life and functional independence of affected patients. Tears in the rotator cuff can either be treated conservatively or surgically depending on patient age, discomfort and disability as well as tear size, depth and location among other factors. Due to the high prevalence of rotator cuff tears, arthroscopic rotator cuff repair (RCR) is one of the most widely performed orthopedic surgeries. As of 2019, over 460,000 rotator cuff repair surgeries were performed in the US and the number of repairs was expected to have a compound annual growth rate of 4% to surpass 570,000 procedures by 2023.[2] There is however, a significant portion of these repairs that are unable to heal and this fact is exacerbated by disease processes like diabetes, osteoporosis, hypercholesterolemia, smoking and malnutrition.[3] The preventable nature of malnutrition makes it a risk factor that should be regularly monitored and addressed in the setting of rotator cuff repair surgery. Adopting an integrated and comprehensive approach, which includes optimizing the patient's nutritional status, is crucial for both pre and postoperative care.

The healing process following RCR surgery involves complex physiological mechanisms, such as inflammation, tissue remodeling, and collagen synthesis[4]. Nutrition plays a crucial role in supporting these processes by providing essential building blocks, facilitating tissue repair, and modulating the inflammatory process. As such, understanding the impact of specific nutrients and dietary interventions on the outcomes of rotator cuff repair becomes an area of growing interest among healthcare professionals and researchers alike.

[1] Department of Orthopaedic Surgery and Rehabilitation Medicine, State University of New York, Downstate Health Sciences University, Brooklyn, New York, United States.

[2] Clinical Assistant Professor, Department of Orthopedic Surgery at NYU Grossman School of Medicine, New York, United States.

***Corresponding Author:** Alex R. La Poche, BA, Department of Orthopaedic Surgery and Rehabilitation Medicine, State University of New York, Downstate Health Sciences University, Brooklyn, New York, United States.

https://doi.org/10.58624/SVOAOR.2025.05.003

Received: November 22, 2024

Published: January 20, 2025

Citation: La Poche AR, Pereira DS. Perioperative Nutrition Optimization in Rotator Cuff Repair. *SVOA Orthopaedics 2024,* 5:1, 19-24. doi: 10.58624/SVOAOR.2025.05.003

This review aims to provide a comprehensive examination of the current literature on nutritional optimization in RCR surgery. By critically analyzing existing studies, we seek to elucidate the role of macronutrients, micronutrients, and supplements in promoting healing, reducing complications, and enhancing overall patient recovery. In doing so, this review aims to highlight the existing gaps in the literature and emphasize the need for prospective clinical trials to investigate the full effect of peri-operative nutritional optimization on surgical outcomes. We seek to initiate a broader dialogue among clinicians and researchers surrounding this topic, paving the way for evidence-based guidelines that integrate nutritional strategies into routine care for patients undergoing RCR surgery.

We firmly believe that a deeper understanding of the relationship between nutrition and rotator cuff repair can have far-reaching implications for clinical practice. By identifying dietary factors that positively impact patient outcomes, healthcare providers can design personalized nutrition plans to optimize the healing process and improve long-term prognosis after RCR surgery.

Rotator Cuff Repair

Rotator cuff repair surgery is performed with the ultimate goal of relieving pain and restoring lost function by reattaching the torn tendon to the humerus bone. When rotator cuff tendons do not heal, patients have worse functional outcomes and more persistent pain.[5] Thus, maximizing rotator cuff tendon healing is essential for achieving optimal patient outcomes. Despite this fact, a significant portion of rotator cuff repairs do not result in tendon healing. According to a Metanalysis carried out by McElvany et al. in 2014 rotator cuff repair surgeries have an average non-healing rate of 26.6%.[6] Another study states that the non-healing and scarring defect incidence rate ranges in the literature from 7 to 57%.[7]

Tendon healing rates are highly dependent on various factors, which can be broadly categorized into three main groups. Firstly, factors related to the nature of the tear, such as tear size, tear configuration, tissue quality and muscle-tendon unit retraction, play a significant role in influencing healing outcomes. For instance, larger tears with poor tissue quality may exhibit decreased healing potential, leading to higher non-healing rates.[3]

Secondly, patient-related factors also exert a substantial impact on tendon healing. Advanced age, compromised overall health status, and non-compliance with postoperative instructions can hinder the body's natural healing mechanisms, contributing to diminished tendon repair. For example, elderly patients with comorbidities such as diabetes, osteoporosis and hypercholesterolemia may experience delayed healing and increased risk of re-tearing after surgery.[8]

Lastly, factors associated with the surgical technique and postoperative rehabilitation can influence the success of rotator cuff repairs. The type of repair performed, the suture technique employed, and the timing and intensity of rehabilitation exercises are critical determinants of tendon healing. Suboptimal surgical techniques or inadequate rehabilitation protocols may lead to subpar outcomes and a higher likelihood of non-healing.[3]

Proper nutrition is a patient-related factor that can be monitored and controlled more easily than other common conditions affecting healing rates, such as diabetes and smoking history. Understanding the interplay of these factors and the role of nutrition is essential in optimizing rotator cuff repair outcomes and improving patient recovery. By identifying and addressing modifiable factors like nutrition, healthcare providers can take proactive steps to enhance tendon healing rates and ultimately enhance the overall success of rotator cuff repair surgeries.

Malnutrition

Malnutrition is a significant concern in the context of surgical outcomes, particularly in orthopedic procedures like rotator cuff repair surgeries. Adequate nutrition plays a crucial role in supporting the healing process and optimizing patient recovery. Malnutrition can encompass protein-energy malnutrition (PEM), micronutrient deficiencies, and obesity although most often in orthopedic literature it is defined as albumin levels below 3.5 g/dL. Other lab tests such as total lymphocyte count (TLC) and transferrin levels can also indicate nutritional status. Poor nutrition as demonstrated by these lab tests as well as Vitamin D levels can adversely affect surgical outcomes and lead to postoperative complications.

Existing research has demonstrated a considerable prevalence of malnutrition in patients undergoing shoulder surgeries. In a study conducted by Garcia et al. 7.6% of patients undergoing total shoulder arthroplasties were found to be malnourished.[9] Similarly, Quan et al. found that the prevalence of malnourishment in arthroscopic rotator cuff repair patients was 3.7%.[10] In both studies these patients had increased risk of complications, extended hospital recovery, blood transfusion and even death. Research has also shown that malnourished patients are more prone to surgical site infections, delayed wound healing and impaired tissue repair.[4,11] Lack of nourishment can compromise immune function thereby increasing the risk of infection and can also impair recovery.[12,13]

Malnutrition exerts its effect on the healing process in rotator cuff repair surgeries through various biological mechanisms. Essential nutrients such as proteins, vitamins and minerals are crucial for collagen synthesis, tissue regeneration and immune function.[4] Patients that are lacking in nourishment can have decreased collagen production, which is vital for proper tissue repair and wound healing. According to Dudrick et al. "All biological amino acids are essential for optimal wound healing and tissue repair.[4] Inadequate protein intake can compromise the body's immune response, increasing susceptibility to infections and delaying the resolution of postoperative inflammation. Additionally, micronutrient deficiencies, such as vitamins C and D, have been linked to impaired bone healing and reduced muscle strength, further compromising the healing process.[14] The lack of adequate nutrients also impacts cellular energy production, hindering cell proliferation and migration, which are crucial for tissue remodeling and repair. Altogether, malnutrition disrupts the finely tuned and coordinated processes involved in the healing response, thereby delaying the recovery and rehabilitation of patients undergoing rotator cuff repair surgeries.

Reconsidering Pre-surgical NPO Fasting Guidelines

Pre-surgical fasting guidelines have long been established as a standard practice to minimize the risk of aspiration during anesthesia. However, recent evidence suggests that existing guidelines might be overly strict, potentially compromising patient nutrition and overall outcomes in rotator cuff repair (RCR) surgery. Historically, patients undergoing RCR surgery are often instructed to observe a "nil per os" (NPO) status after midnight, which involves abstaining from all oral intake, including food and fluids. The intention behind this approach is to reduce the risk of aspiration-related complications during anesthesia.[15] In J. Roger Maltby's chapter on fasting from midnight, he describes this convention by saying, "The false premise that patients who ingest anything (food or clear liquid) on the day of surgery have a 'full stomach' led logically to enforcement of the dogmatic 'NPO after midnight' rule."[16] Maltby is alluding to the fact that while this practice has been the norm for decades, emerging research raises concerns about its universal implementation's impact on patients' nutritional status and overall health before surgery.

The American Society of Anesthesiologists' evidence based guideline for periprocedural aspiration risk suggests that healthy nonpregnant patients should fast for 8 hours after heavy meals, 6 hours after a light, non-fatty meal, and 2 hours after clear liquids (eg, water, fruit juices without pulp, carbonated beverages, black coffee).[17] This guideline leaves significant room for nutrition optimization in patients undergoing elective surgeries such as rotator cuff repairs. The extended periods of NPO fasting that patients regularly endure before surgery can lead to a state of fasting-induced stress response in the body. Prolonged fasting may trigger a catabolic state, depleting glycogen stores, and initiating protein breakdown, potentially compromising muscle mass and immune function.[18] Patients undergoing RCR surgery often present with nutritional deficiencies or are at risk of malnutrition, and strict pre-surgical fasting can exacerbate these issues.

Nutritional state should therefore be included in patient's preoperative assessment to identify patients at risk of malnutrition or those with specific nutrient deficiencies. A personalized nutritional plan can be designed for each patient, considering their specific nutritional needs and optimizing their preoperative nutritional status. Nutritional interventions may involve oral nutritional supplements (such as protein powders or carbohydrate loading mixes), targeted micronutrient support, and, in some cases, parenteral nutrition when necessary.

Nutrition Optimization

Nutrition has been established as a critical determinant in the healing and recovery process in orthopedic surgeries. Specifically, albumin, vitamin D, and transferrin levels as well as total lymphocyte count (TLC) have all been shown to be determinants of successful healing and recovery. The importance of monitoring the levels of these nutrients and providing supplemental nutrition to deficient rotator cuff repair patients both before and after surgery has only just begun to be explored.

Albumin is a crucial blood protein that has been widely used as an indicator of overall nutrition status. Serum albumin is an indicator of visceral protein reserves and protein malnutrition is associated with an albumin level of less than 3.5 g/dL if liver function is nomal.[19] The substandard outcomes of surgical patients below this threshold have repeatedly demonstrated just how essential adequate protein intake is for collagen synthesis, tissue regeneration, and wound healing. In a recent randomized controlled trial on the effect of amino acid supplementation on hip fracture patients, it was shown that essential amino acid supplementation induced significant improvements in the sarcopenic sub-population of the study.[20] Other non hip fracture specific studies have shown that amino acid and carbohydrate supplementation can ameliorate the loss of lean muscle mass and decrease the risk of sarcopenia for immobile or bedridden patients.[21] Specialized amino acid mixtures with components such as arginine, Hydroxymethylbutyrate (HMB) and glutamine can enhance collagen synthesis and therefore be used as a nutritional means for enhancing wound repair.[22]

This makes conditionally essential amino acids (CEAAs) protective against common complications and skeletal muscle wasting when administered to patients postoperatively. The ingestion of amino acids is also directly linked to gamma globulin and antibody production which makes sufficient protein metabolism an essential component of infection resistance.[23]

The existing evidence that amino acid supplementation can be used as a means to boost protein levels both pre and post-surgery should be further explored in the context of rotator cuff repair. Perioperative protein supplementation's potential to enhance the body's healing mechanisms makes it a viable, simple and potentially cheap method for improving RCR surgical outcomes.

Similarly to albumin monitoring and amino acid supplementation, vitamin D's inherent functional qualities should also be optimized to maximize surgical outcomes. The fat-soluble vitamin plays essential roles in bone health, muscle function and immune system modulation. Its active form, 1,25 dihydroxy vitamin D, is responsible for calcium and phosphate absorption and bone modulation. In addition to its invaluable effect on bone density and repair, vitamin D has been shown to decrease inflammation through downregulation of tumor-necrosis factor-alpha[24], to improve muscle growth through receptors on myocytes[25] and to regulate matrix metalloproteinase (MMP-9).[26] Recently rat studies have demonstrated that its blocking of MMP allows it to strengthen the postprocedural tendon to bone scar thereby increasing the effectiveness of tendon healing.[14] Additionally, a human database study showed that low vitamin D levels were associated with greater rates of revision rotator cuff repair surgery (5.9%) compared with those with sufficient vitamin D levels (3.7%).[27]The success of RCR surgery is dependent on the torn tendon's ability to heal to its bony attachment on the humerus; therefore, vitamin D's role in tendon healing should be operationalized and further explored in vivo.

Despite its undeniable importance, vitamin D deficiency is estimated to affect 1 billion people worldwide.[28] This deficiency has been linked to poor bone healing, decreased muscle strength and poor tendon healing. Consequently, optimizing Vitamin D levels pre-operatively may prove beneficial in promoting bone repair and enhancing overall patient recovery. Vitamin D supplements are a simple therapy for patients to take and for doctors to prescribe and should therefore be beneficial for rotator cuff repair patients especially if further evidence is found to demonstrate its beneficial effect on tendon repair.

A growing body of evidence underscores the importance of immunonutrition in perioperative care. A systematic review and meta-analysis by Matsui et al. demonstrated that perioperative immunonutrition, which includes key components such as arginine, omega-3 fatty acids, and glutamine, significantly reduces total postoperative complications and infectious complications in patients undergoing elective head and neck or gastrointestinal cancer surgeries[29]. These findings highlight the potential for targeted nutritional interventions to mitigate surgical stress, enhance immune function, and accelerate recovery through mechanisms such as inflammation modulation and improved protein synthesis. While the study focused on cancer surgeries, the principles of reducing postoperative complications through immunonutrition are transferable to rotator cuff repair, where adequate immune response and tissue regeneration are critical. The demonstrated effectiveness of arginine-enriched formulations in preventing complications further supports the integration of specialized amino acid supplementation into perioperative nutritional protocols, warranting exploration in orthopedic surgical settings.

While monitoring patient nutrition, transferrin and total lymphocyte count (TLC) can also be evaluated as serum markers that can potentially foreshadow outcomes and indicate nutritional status. Transferrin is a vital protein involved in iron transport and TLC is an essential marker of the body's immune response. As Lymphocytes are protein-based cells both low TLC and transferrin can indicate a lack of visceral protein just as albumin does. surgical outcomes. Additionally, low TLC count indicates compromised immune function thereby significantly increasing the patient's risk of postoperative infection and prolonged inflammation. In malnourished or sarcopenic patients, amino acid supplementation may also be useful to raise the levels of these markers[30,31] although more research must be done to determine their impact on surgical outcomes.

Conclusion

In conclusion, malnutrition has been identified as a significant concern affecting surgical outcomes, including in rotator cuff repair surgeries. Adequate nutrition plays a crucial role in supporting the healing process and optimizing patient recovery. Malnutrition can encompass protein-energy malnutrition (PEM), micronutrient deficiencies, and obesity, with albumin levels, Vitamin D, total lymphocyte count (TLC), and transferrin serving as crucial indicators of nutritional status.

To address the impact of malnutrition on rotator cuff healing and surgical outcomes, healthcare providers can implement various strategies for identifying and managing malnutrition. A comprehensive nutritional assessment using validated screening tools such as the Malnutrition Universal Screening Tool (MUST) or the Subjective Global Assessment (SGA) can help identify malnourished or at-risk patients. Collaboration with registered dietitians can further aid in developing personalized nutrition plans and monitoring progress throughout the pre and postoperative phases.

Preoperative nutritional optimization, including dietary interventions and oral nutritional supplements, can be prescribed to improve nutrient intake and support the patient's nutritional status before surgery, positively impacting postoperative outcomes. Moreover, providing adequate postoperative nutritional support through nutrient-dense meals and targeted supplementation can facilitate healing and recovery.

Vitamin and mineral supplementation, such as Vitamin D, has been shown to enhance bone healing, muscle strength and potentially tendon repair, contributing to the success of rotator cuff surgery. Education and counseling about the importance of nutrition in the healing process can motivate patients to actively engage in improving their dietary habits.

Regular monitoring of the patient's nutritional status during hospitalization and post-discharge is crucial to address any changes in nutritional requirements promptly. Follow-up visits with the dietitian and surgical team allow for tracking progress and adjusting the nutritional plan as needed.

By adopting evidence-based strategies for addressing malnutrition, healthcare providers can optimize surgical outcomes, promote successful healing, and contribute to the overall well-being and quality of life for patients undergoing rotator cuff repair surgery. Further research, including prospective clinical trials on the efficacy of nutrition optimization, is needed to explore the potential benefits of amino acid supplementation and Vitamin D optimization in enhancing tendon healing and patient recovery. Overall, a holistic and personalized approach to nutrition optimization has the potential to improve the success and long-term prognosis of rotator cuff repair surgeries.

Conflicts of Interest

The authors do not have any proprietary interests in the materials described in this article.

References

1. Tashjian RZ. Epidemiology, Natural History, and Indications for Treatment of Rotator Cuff Tears. Clinics in Sports Medicine. 2012;31(4):589-604.
2. Hodakowski AJ, Mccormick JR, Damodar D, et al. Rotator cuff repair: what questions are patients asking online and where are they getting their answers? Clinics in Shoulder and Elbow. 2023.
3. Abtahi AM, Granger EK, Tashjian RZ. Factors affecting healing after arthroscopic rotator cuff repair. World J Orthop. 2015;6 (2):211-220.
4. Dudrick SJ. The Role of Nutrition in Wound Healing. In: Critical Issues in Surgery. Springer US; 1995:1-12.
5. Cho NS, Rhee YG. The Factors Affecting the Clinical Outcome and Integrity of Arthroscopically Repaired Rotator Cuff Tears of the Shoulder. Clinics in Orthopedic Surgery. 2009;1(2):96.
6. McElvany MD, McGoldrick E, Gee AO, Neradilek MB, Matsen FA. Rotator Cuff Repair:Published Evidence on Factors Associated With Repair Integrity and Clinical Outcome. The American Journal of Sports Medicine. 2015;43(2):491-500.
7. Martel M, Laumonerie P, Girard M, Dauzere F, Mansat P, Bonnevialle N. Does vitamin C supplementation improve rotator cuff healing? A preliminary study. European Journal of Orthopaedic Surgery & Traumatology. 2022;32(1):63-70.
8. Jensen AR, Taylor AJ, Sanchez-Sotelo J. Factors Influencing the Reparability and Healing Rates of Rotator Cuff Tears. Current Reviews in Musculoskeletal Medicine. 2020;13(5):572-583.
9. Garcia GH, Fu MC, Dines DM, Craig EV, Gulotta LV. Malnutrition: a marker for increased complications, mortality, and length of stay after total shoulder arthroplasty. Journal of Shoulder and Elbow Surgery. 2016;25(2):193-200.
10. Quan T, Lopez JD, Chen FR, et al. A retrospective study evaluating the association between hypoalbuminemia and postoperative outcomes for patients receiving open rotator cuff repair. Journal of Orthopaedics. 2022;30:88-92.
11. Yuwen P, Chen W, Lv H, et al. Albumin and surgical site infection risk in orthopaedics: a meta-analysis. BMC Surgery. 2017;17 (1).
12. Choi JT, Yoshida B, Jalali O, Hatch GF. Malnutrition in Orthopaedic Sports Medicine: A Review of the Current Literature. Sports Health: A Multidisciplinary Approach. 2021;13(1):65-70.
13. O'Daly BJ, Walsh JC, Quinlan JF, et al. Serum albumin and total lymphocyte count as predictors of outcome in hip fractures. Clinical Nutrition. 2010;29(1):89-93.

14. Agrawal D, Dougherty K, Dilisio M. Vitamin D and the immunomodulation of rotator cuff injury. Journal of Inflammation Research. 2016:123.

15. Black MK, Lupa MC, Lemley LW, Dreesen EB, Deaton AM, Wardrop RM, 3rd. Things We Do for No Reason™: NPO After Midnight. J Hosp Med. 2021;16(6):368-370.

16. Maltby JR. Fasting from midnight – the history behind the dogma. Best Practice & Research Clinical Anaesthesiology. 2006;20 (3):363-378.

17. Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration: Application to Healthy Patients Undergoing Elective Procedures: An Updated Report by the American Society of Anesthesiologists Task Force on Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration*. Anesthesiology. 2017;126(3):376-393.

18. Evans DC, Martindale RG, Kiraly LN, Jones CM. Nutrition Optimization Prior to Surgery. Nutrition in Clinical Practice. 2014;29(1):10-21.

19. Tietze KJ. Chapter 5 - Review of Laboratory and Diagnostic Tests. In: Tietze KJ, ed. Clinical Skills for Pharmacists (Third Edition). Saint Louis: Mosby; 2012:86-122.

20. Rondanelli M, Guido D, Faliva MA, et al. Effects of essential amino acid supplementation on pain in the elderly with hip fractures: a pilot, double-blind, placebo-controlled, randomised clinical trial. J Biol Regul Homeost Agents. 2020;34(2):721-731.

21. Paddon-Jones D, Sheffield-Moore M, Urban RJ, et al. Essential Amino Acid and Carbohydrate Supplementation Ameliorates Muscle Protein Loss in Humans during 28 Days Bedrest. The Journal of Clinical Endocrinology & Metabolism. 2004;89(9):4351-4358.

22. Williams JZ, Abumrad N, Barbul A. Effect of a specialized amino acid mixture on human collagen deposition. Ann Surg. 2002;236(3):369-374; discussion 374-365.

23. Cannon PR, Wissler RW, Woolridge RL, Benditt EP. The Relationship of Protein Deficiency to Surgical Infection. Ann Surg. 1944;120(4):514-525.

24. Bahar-Shany K, Ravid A, Koren R. Upregulation of MMP-9 production by TNFÎ± in keratinocytes and its attenuation by vitamin D. Journal of Cellular Physiology. 2009:n/a-n/a.

25. Cipriani C, Pepe J, Piemonte S, Colangelo L, Cilli M, Minisola S. Vitamin D and Its Relationship with Obesity and Muscle. International Journal of Endocrinology. 2014;2014:1-11.

26. Timms PM, Mannan N, Hitman GA, et al. Circulating MMP9, vitamin D and variation in the TIMP-1 response with VDR genotype: mechanisms for inflammatory damage in chronic disorders? Qjm. 2002;95(12):787-796.

27. Cancienne JM, Brockmeier SF, Kew ME, Werner BC. Perioperative Serum 25-Hydroxyvitamin D Levels Affect Revision Surgery Rates After Arthroscopic Rotator Cuff Repair. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2019;35(3):763 -769.

28. Holick MF. Vitamin D Deficiency. New England Journal of Medicine. 2007;357(3):266-281.

29. Matsui R, Sagawa M, Sano A, et al. Impact of Perioperative Immunonutrition on Postoperative Outcomes for Patients Undergoing Head and Neck or Gastrointestinal Cancer Surgeries: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Annals of Surgery. 2024;279(3):419-428.

30. Kristian YY, Cahyanur R, Wulandari Y, et al. Correlation between branched-chain amino acids intake and total lymphocyte count in head and neck cancer patients: a cross-sectional study. BMC Nutrition. 2023;9(1).

31. Enko D, Moro T, Holasek S, et al. Branched-chain amino acids are linked with iron metabolism. Annals of Translational Medicine. 2020;8(23):1569-1569.