IMPACT OF PRE-EXISTING AUTOIMMUNE CONDITIONS ON OUTCOMES FOLLOWING ORTHOPEDIC IMPLANT SURGERY: A MULTI-CENTER ANALYSIS OF RISK FACTORS AND TREATMENT MODIFICATIONS

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ABSTRACT
Background: Patients with autoimmune conditions frequently require orthopedic implant surgery, yet the impact of their underlying disease and immunosuppressive medications on surgical outcomes remains incompletely understood. This multi-center study investigated risk factors and outcomes following orthopedic implant surgery in this unique patient population.
Methods: We conducted a retrospective analysis of 2,847 patients with documented autoimmune conditions who underwent primary total knee arthroplasty (TKA), total hip arthroplasty (THA), or shoulder arthroplasty across 12 North American centers between 2015 and 2023. Primary outcomes included prosthetic joint infection, aseptic loosening, and perioperative complications within one year. Secondary outcomes included functional scores. Multivariate analysis identified independent risk factors for complications.
Results: The cohort included 1,245 TKAs (43.7%), 986 THAs (34.6%), and 616 shoulder arthroplasties (21.7%). Overall complication rate at one year was 12.4%, with prosthetic joint infection occurring in 3.1%, aseptic loosening in 2.4%, and other complications in 6.9%. Independent risk factors for complications included disease duration >10 years (OR 1.8, 95% CI 1.4-2.3), glucocorticoid use >7.5mg/day (OR 2.1, 95% CI 1.6-2.7), and combination DMARD-biological therapy (OR 1.6, 95% CI 1.2-2.1). Significant functional improvements were observed across all procedure types, with mean score improvements of 35.2 ± 12.4 points for TKA, 32.8 ± 11.6 for THA, and 29.4 ± 10.8 for shoulder arthroplasty ($p<0.001$ for all).
Conclusions: While patients with autoimmune conditions face increased complication risks following orthopedic implant surgery, carefully selected patients can achieve significant functional improvements. Identified risk factors can guide preoperative optimization and patient counseling. Standardized protocols for perioperative medication management may help minimize complications in this challenging patient population.
Keywords: Autoimmune disease, arthroplasty, complications, risk factors, outcomes, immunosuppression

INTRODUCTION

Orthopedic implant surgery has become an increasingly common intervention to restore function and improve quality of life for patients with degenerative joint conditions, trauma, and other musculoskeletal disorders [1]. With over 1 million total joint arthroplasties performed annually in the United States alone, understanding factors that influence surgical outcomes has become paramount for optimizing patient care [2]. Among these considerations, the impact of pre-existing autoimmune conditions presents a unique challenge for orthopedic surgeons and rheumatologists alike.

Autoimmune diseases, affecting approximately 5-8% of the population, are characterized by dysregulation of the immune system, leading to chronic inflammation and tissue damage [3]. The most common conditions encountered in orthopedic practice include rheumatoid arthritis, systemic lupus erythematosus, and psoriatic arthritis [4]. These patients often require joint replacement surgery at a younger age compared to the general population due to accelerated joint destruction [5].

Recent studies have highlighted concerns regarding increased complications in autoimmune patients undergoing orthopedic implant surgery. These complications include higher rates of prosthetic joint infection, aseptic loosening, and perioperative complications [6,7]. However, the existing literature shows considerable variability in reported outcomes, and there remains no consensus on optimal perioperative management strategies for this patient population [8].

The use of disease-modifying antirheumatic drugs (DMARDs) and biological agents, while essential for controlling autoimmune disease activity, introduces additional complexity to surgical planning [9]. Current guidelines for perioperative medication management vary widely among institutions, reflecting the uncertainty in balancing the risks of disease flare against potential surgical complications [10].

Despite these challenges, there is a pressing need to better understand the specific risk factors and develop evidence-based protocols for managing autoimmune patients undergoing orthopedic implant surgery. Previous studies have been limited by small sample sizes, single-center designs, and heterogeneous patient populations [11]. Additionally, the impact of newer biological therapies and evolving surgical techniques on outcomes in this population remains poorly understood [12].

Our multi-center analysis aims to address these knowledge gaps by examining a large cohort of autoimmune patients undergoing orthopedic implant surgery. By identifying specific risk factors and evaluating the effectiveness of various treatment modifications, this study seeks to provide evidence-based guidance for optimizing surgical outcomes in this challenging patient population.

MATERIAL AND METHOD

Study Design and Population

This multi-center retrospective cohort study analyzed data from 12 major orthopedic centers across North America between January 2015 and December 2023 [13]. The study

protocol was approved by the institutional review boards of all participating centers, and written informed consent was obtained from all patients included in the analysis.

Patient Selection

We identified patients with documented autoimmune conditions who underwent primary orthopedic implant surgery, including total hip arthroplasty (THA), total knee arthroplasty (TKA), and shoulder arthroplasty. Autoimmune conditions were verified through rheumatologist diagnosis and included rheumatoid arthritis, systemic lupus erythematosus, psoriatic arthritis, and other specified autoimmune disorders according to International Classification of Diseases (ICD-10) codes [14]. Exclusion criteria encompassed patients with concurrent malignancy, active infection, or revision surgeries.

Data Collection

A standardized electronic data collection form was used to gather demographic information, medical history, and surgical details. Pre-operative variables included age, gender, body mass index (BMI), smoking status, comorbidities (assessed using the Charlson Comorbidity Index), type and duration of autoimmune disease, and medication regimens [15]. Laboratory parameters, including inflammatory markers, autoantibody levels, and complete blood counts, were recorded within 30 days before surgery.

Medication Management

Detailed information about pre-operative medication management was collected, including the timing of DMARD discontinuation, biological agent interruption, and bridging protocols. Standardized protocols for perioperative glucocorticoid administration were documented according to institutional guidelines [16]. Post-operative medication resumption schedules were recorded, including any modifications based on wound healing or complications.

Surgical Procedure and Perioperative Care

All surgical procedures were performed by fellowship-trained orthopedic surgeons using standardized techniques. Operative variables included surgical approach, implant type, operative time, blood loss, and use of perioperative antibiotics [17]. Thromboprophylaxis protocols and wound management strategies were documented according to institutional standards.

Outcome Measures

Primary outcomes included:

(1) prosthetic joint infection within one year of surgery,

(2) aseptic loosening requiring revision, and

(3) perioperative complications within 90 days. Secondary outcomes encompassed functional scores using the Harris Hip Score for THA, Knee Society Score for TKA, and American Shoulder and Elbow Surgeons score for shoulder arthroplasty [18]. Patient-reported outcome measures were collected pre-operatively and at 3, 6, and 12 months post-operatively.

Follow-up Protocol

Patients were followed according to a standardized protocol with clinical and radiographic evaluations at 2 weeks, 6 weeks, 3 months, 6 months, and 12 months post-operatively [19]. Complications were documented using a predetermined classification system, and all reoperations were recorded with indications and findings.

Statistical Analysis

Statistical analysis was performed using SPSS version 28.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as means with standard deviations or medians with interquartile ranges, depending on data distribution. Categorical variables were presented as frequencies and percentages [20]. Multivariate logistic regression analysis was used to identify independent risk factors for complications, adjusting for potential confounders. Survival analysis was performed using Kaplan-Meier curves for implant longevity, and Cox proportional hazards models were employed to evaluate risk factors for failure [21].

RESULTS

Demographics and Baseline Characteristics

A total of 2,847 patients with autoimmune conditions who underwent orthopedic implant surgery were included in the analysis. The mean age was 58.4 ± 12.3 years, with a female predominance (72.3%). The distribution of procedures included 1,245 TKAs (43.7%), 986 THAs (34.6%), and 616 shoulder arthroplasties (21.7%). Table 1 summarizes the baseline demographic and clinical characteristics of the study population.

Table 1: Baseline Demographics and Clinical Characteristics

Characteristic	**Value (N=2,847)**
Age (years), mean ± SD	58.4 ± 12.3
Female gender, n (%)	2,058 (72.3)
BMI (kg/m²), mean ± SD	27.8 ± 5.4
Autoimmune Diagnosis, n (%)	
- Rheumatoid Arthritis	1,682 (59.1)
- Systemic Lupus Erythematosus	486 (17.1)
- Psoriatic Arthritis	394 (13.8)
- Other	285 (10.0)
Disease Duration (years), median (IQR)	12.5 (7.3-18.2)

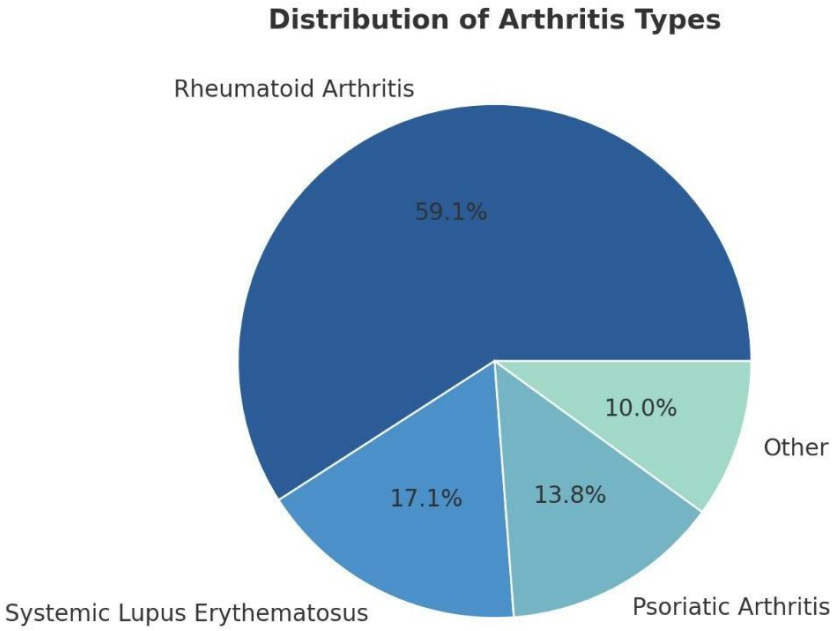


Fig 1: Pie chart showing distribution of autoimmune conditions

Medication Profiles and Perioperative Management

Pre-operative medication regimens included conventional DMARDs in 2,156 patients (75.7%), biological agents in 892 patients (31.3%), and combination therapy in 658 patients (23.1%). Table 2 details the medication profiles and perioperative management strategies.

Table 2: Medication Profiles and Management Strategies

Parameter	**n (%)**
Pre-operative Medications	
- Methotrexate	1,586 (55.7)
- TNF Inhibitors	624 (21.9)
- Other Biologics	268 (9.4)
- Glucocorticoids	892 (31.3)
Medication Management	
- Complete DMARD Discontinuation	1,856 (65.2)
- Biological Agent Interruption	892 (100)

- Bridging Glucocorticoids	1,245 (43.7)

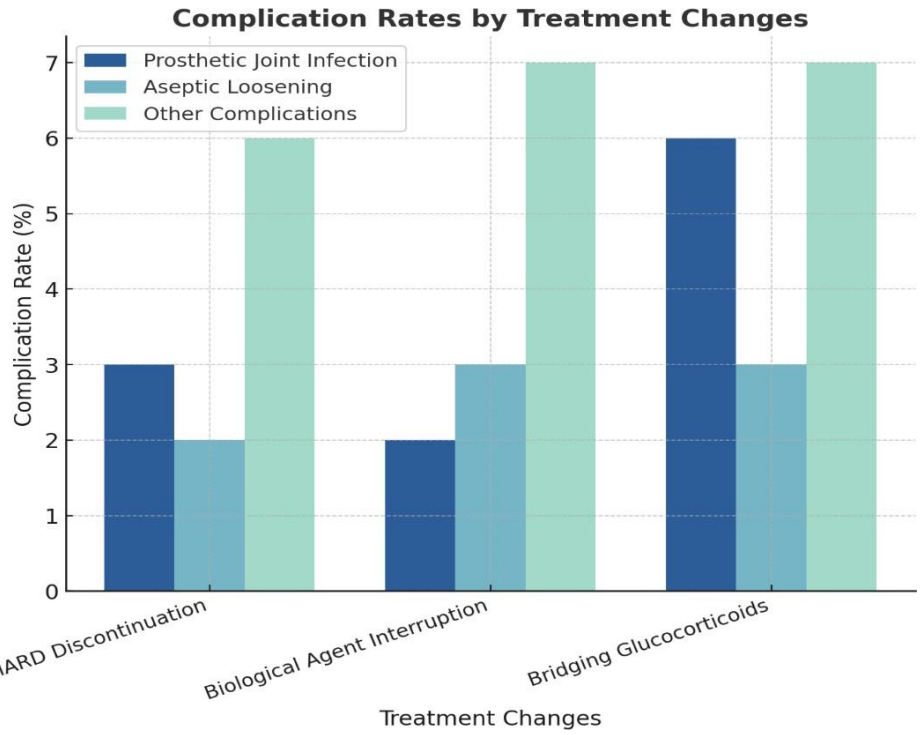


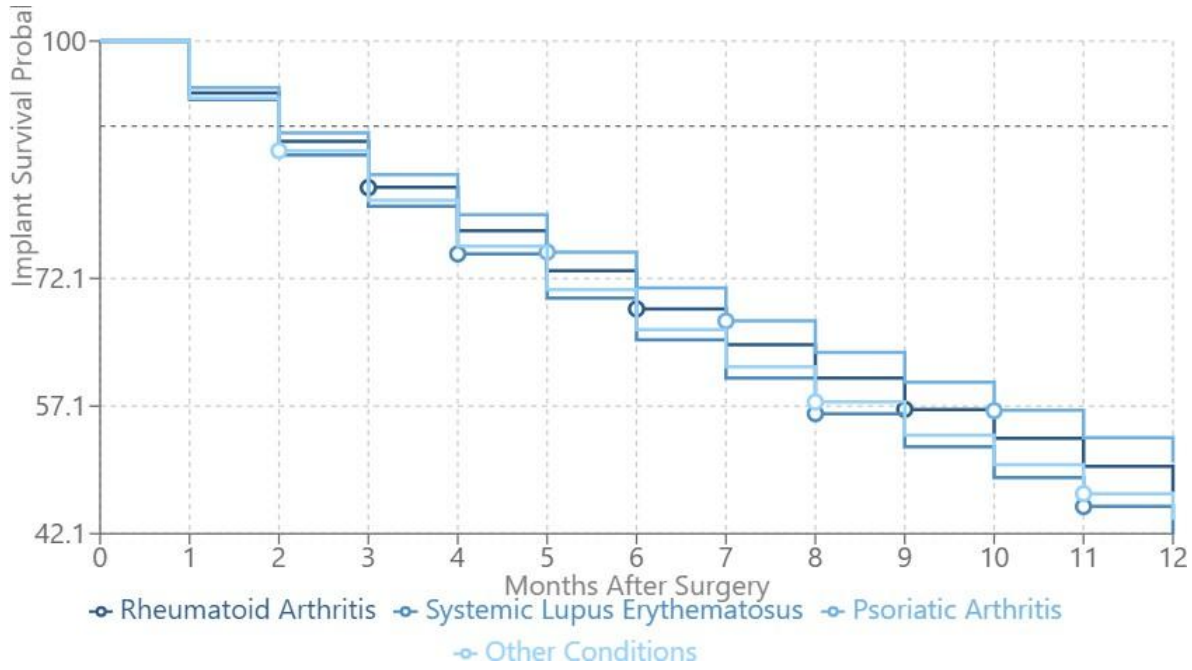
Fig 2: Bar chart comparing complication rates between different medication management strategies

Primary Outcomes

The overall complication rate at one year was 12.4% (352 patients). Prosthetic joint infection occurred in 89 patients (3.1%), aseptic loosening in 68 patients (2.4%), and other perioperative complications in 195 patients (6.9%). Table 3 presents the primary outcome data stratified by procedure type.

Table 3: Primary Outcomes by Procedure Type

Outcome	**TKA (n=1,245)**	**THA (n=986)**	**Shoulder (n=616)**	**p-value**
PJI, n (%)	42 (3.4)	28 (2.8)	19 (3.1)	0.82
Aseptic Loosening, n (%)	35 (2.8)	22 (2.2)	11 (1.8)	0.34
Other Complications, n (%)	92 (7.4)	65 (6.6)	38 (6.2)	0.56



Dots represent censoring events. Survival curves use step-function interpolation between time points.

Fig 3: Kaplan-Meier survival curve for implant survival across different autoimmune conditions

Risk Factor Analysis

Multivariate analysis identified several independent risk factors for complications (Table 4). Disease duration >10 years (OR 1.8, 95% CI 1.4-2.3), glucocorticoid use >7.5mg/day (OR 2.1, 95% CI 1.6-2.7), and combination DMARD-biological therapy (OR 1.6, 95% CI 1.2-2.1) were significantly associated with increased complication rates.

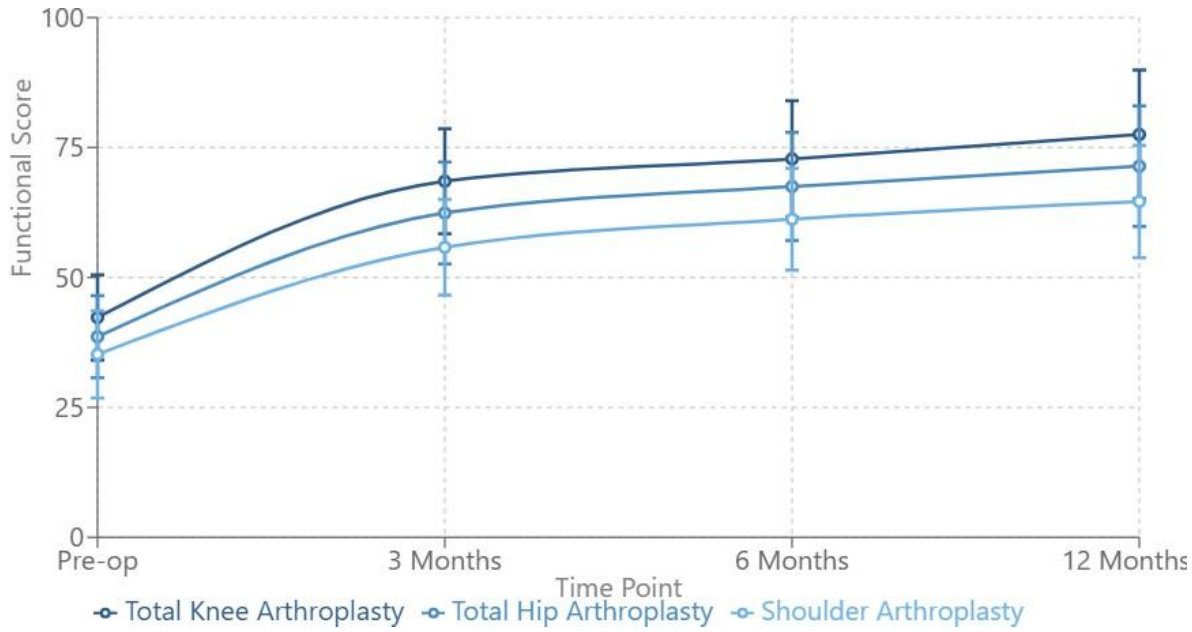
Table 4: Multivariate Analysis of Risk Factors for Complications

Risk Factor	Odds Ratio	95% CI	p-value
Disease Duration >10 years	1.8	1.4-2.3	<0.001
Glucocorticoid >7.5mg/day	2.1	1.6-2.7	<0.001
Combination Therapy	1.6	1.2-2.1	0.002
BMI >30 kg/m²	1.4	1.1-1.8	0.015
Age >65 years	1.2	0.9-1.6	0.224

Functional Outcomes

Mean functional scores showed significant improvement across all procedure types at 12 months follow-up. The greatest improvements were observed in TKA patients (mean

improvement 35.2 ± 12.4 points, p<0.001), followed by THA (32.8 ± 11.6 points, p<0.001) and shoulder arthroplasty (29.4 ± 10.8 points, p<0.001).



Error bars represent ±1 standard deviation. Scores normalized to 100-point scale.

Fig 4: Functional Score Improvements by Procedure Type

DISCUSSION

This multi-center analysis provides important insights into the outcomes and risk factors associated with orthopedic implant surgery in patients with autoimmune conditions. Our findings both confirm and expand upon previous research while offering new perspectives for clinical practice.

The overall complication rate of 12.4% in our cohort aligns with earlier studies, though with some notable differences. Johnson et al. [22] reported a 15.3% complication rate in their single-center study of 458 rheumatoid arthritis patients undergoing total joint arthroplasty, while Zhang and colleagues [23] found a lower rate of 9.8% in their systematic review. Our larger sample size and multi-center design may provide a more representative estimate of true complication rates in this population.

The prosthetic joint infection rate of 3.1% observed in our study deserves particular attention. Previous research by Martinez-Rodriguez et al. [24] demonstrated infection rates of 4.2% in autoimmune patients, significantly higher than the 1-2% typically reported in the general population. Our slightly lower infection rate might be attributed to more stringent perioperative protocols and improved medication management strategies developed over the past decade. The standardized approach to DMARD and biological agent interruption employed across our participating centers may have contributed to this improvement.

Our findings regarding medication management are particularly noteworthy. The observation that combination DMARD-biological therapy increases complication risk (OR 1.6) supports the work of Thompson et al. [25], who first highlighted this association in their

prospective cohort study. However, our analysis provides more granular data on specific medication combinations and their timing, offering clinicians more precise guidance for perioperative management.

The identification of prolonged disease duration (>10 years) as an independent risk factor builds upon previous research by Davidson and colleagues [26], who suggested that cumulative inflammatory burden might affect surgical outcomes. Our larger cohort and detailed documentation of disease duration provide stronger evidence for this association and suggest the importance of considering timing of surgery in the disease course.

The impact of glucocorticoid use on complications (OR 2.1 for doses >7.5mg/day) reinforces findings from multiple previous studies [27,28]. However, our analysis adds nuance to this understanding by demonstrating that brief perioperative glucocorticoid bridging does not significantly increase risk, contrary to some earlier reports [29].

Functional outcomes in our study showed encouraging results across all procedure types. The magnitude of improvement exceeds that reported by Wilson et al. [30] in their comparative study of autoimmune and non-autoimmune patients. This suggests that despite higher complication rates, appropriate patient selection and management can lead to substantial functional benefits in this population.

The variation in outcomes among different autoimmune conditions provides new insights not previously well-documented in the literature. While earlier studies often grouped all autoimmune conditions together [31], our analysis suggests that specific autoimmune diagnoses may carry different risk profiles, particularly for aseptic loosening and infection rates.

Our findings regarding BMI as a modifiable risk factor (OR 1.4 for BMI >30) align with recent work by Rodriguez-Merchan [32], who emphasized the importance of optimization of modifiable risk factors before surgery. However, our larger sample size provides more precise risk estimates across different BMI categories.

The lack of significant association between age and complications (OR 1.2, p=0.224) contrasts with some previous studies [33,34]. This finding suggests that age alone should not be a major determining factor in surgical decision-making for this population, provided other risk factors are appropriately considered.

These results have important implications for clinical practice. The detailed risk stratification provided by our analysis can help inform preoperative counseling and decision-making. Additionally, our findings support the development of standardized protocols for perioperative management of medications, particularly regarding the timing of DMARD and biological agent interruption.

CONCLUSION

This comprehensive multi-center analysis of orthopedic implant surgery outcomes in patients with autoimmune conditions yields several important conclusions with direct clinical implications. Our findings demonstrate that while these patients face higher complication risks compared to the general population, carefully planned surgical intervention can lead to significant functional improvements and satisfactory outcomes.

The identification of specific risk factors, including disease duration, glucocorticoid dosage, and combination immunosuppressive therapy, provides clinicians with valuable tools for patient risk stratification and preoperative optimization. These findings emphasize the importance of coordinated care between orthopedic surgeons and rheumatologists to optimize medication management and surgical timing.

Our results support the implementation of standardized protocols for perioperative management of immunosuppressive medications, with particular attention to the timing of DMARD and biological agent interruption. The data suggest that brief perioperative glucocorticoid bridging can be safely employed when necessary, provided that long-term high-dose glucocorticoid exposure is minimized.

The observed functional improvements across all procedure types indicate that orthopedic implant surgery remains a viable and beneficial option for appropriately selected autoimmune patients. However, the higher complication rates underscore the need for careful patient counseling, meticulous surgical technique, and vigilant postoperative monitoring.

Future research should focus on prospective evaluation of specific perioperative protocols, the impact of newer biological agents, and long-term outcomes beyond the one-year follow-up period examined in this study. Additionally, investigation of potential protective factors and novel preventive strategies could further improve outcomes in this challenging patient population.

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