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Evaluation of Long-Term Graft Survival and Immune Reconstitution in Pediatric Patients Undergoing Bone Marrow Transplantation for Acute Lymphoblastic Leukemia

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Abstract

Bone marrow transplantation (BMT) remains a critical therapeutic option for pediatric patients with acute lymphoblastic leukemia (ALL), particularly for those with high-risk or relapsed disease. This study aimed to evaluate long-term graft survival, immune reconstitution, and overall outcomes in pediatric patients undergoing allogeneic BMT. A retrospective analysis of 150 pediatric patients who underwent BMT between 2010 and 2020 was conducted. The median follow-up was 7.5 years. The primary endpoints included overall survival (OS), event-free survival (EFS), graft-versus-host disease (GVHD) incidence, and immune reconstitution dynamics. Our results demonstrated an overall survival rate of 72% at 5 years, with significant improvement in immune reconstitution observed within the first 12 months post-transplant. Chronic GVHD was observed in 30% of patients, with most cases being mild to moderate in severity. The study concludes that BMT remains an effective treatment for pediatric ALL, with promising long-term survival rates and manageable complications.

Keywords: Bone marrow transplantation; Acute lymphoblastic leukemia; Pediatric oncology; Graft-versus-host disease; Immune reconstitution; Long-term survival

Introduction

Bone marrow transplantation (BMT) has established itself as a pivotal treatment modality for various hematological malignancies, including acute lymphoblastic leukemia (ALL) [1]. ALL is the most common pediatric malignancy, and while advancements in chemotherapy have significantly improved survival rates, certain high-risk or relapsed patients require more intensive treatment options such as BMT. The success of BMT in pediatric patients depends on several factors, including the selection of suitable donors, pre-conditioning regimens, and post-transplant care, particularly immune reconstitution and the management of graft-versus-host disease (GVHD) [2]. Despite the high success rates, BMT is associated with potential complications, such as GVHD, infections due to delayed immune recovery, and relapse of the underlying disease. Therefore, long-term follow-up studies are essential to understanding the dynamics of graft survival, immune reconstitution, and the overall health of pediatric patients post-BMT. This study aims to provide insights into these aspects by evaluating a cohort of pediatric patients who underwent BMT for ALL at a single center over a decade [3].

Results

Patient characteristics and transplant outcomes

Of the 150 patients included, 85 (57%) were male, and 65 (43%) were female. The median age at transplant was 10 years. Matched sibling donors (MSD) were used for 55% of the transplants, while 45% received grafts from unrelated donors (URD). The overall survival (OS) rate at 5 years post-transplant was 72%, with an event-free survival (EFS) rate of 65% [4].

Immune reconstitution

Immune reconstitution, particularly the recovery of CD4+ and CD8+ T-cells, was observed within the first 12 months post-transplant in the majority of patients. Median CD4+ T-cell counts reached 200 cells/μL by 6 months and 400 cells/μL by 12 months post-transplant. CD8+ T-cell reconstitution followed a similar pattern, with median counts of 250 cells/μL at 6 months and 500 cells/μL at 12 months [5].

Graft-versus-host disease

Acute GVHD was observed in 45% of patients, with grade II-IV GVHD occurring in 30%. Chronic GVHD developed in 30% of patients, with most cases being mild to moderate in severity. The incidence of GVHD was higher in patients receiving grafts from unrelated donors compared to matched sibling donors [6].

Discussion

This study reaffirms the critical role of bone marrow transplantation (BMT) in the management of pediatric acute lymphoblastic leukemia (ALL), demonstrating a 5-year overall survival rate of 72% and an event-free survival rate of 65% [7]. Our findings highlight the effectiveness of BMT in achieving long-term remission for high-risk and relapsed ALL patients, aligning with previous studies that underscore the importance of BMT in this cohort. One of the key insights from our study is the pattern of immune reconstitution post-transplant. The recovery of CD4+ and CD8+ T-cells within the first year is consistent with the expected immune recovery trajectory, supporting the role of early immune reconstitution in improving patient outcomes and reducing the risk of infections and relapse [8]. This aligns with other research emphasizing the significance of immune reconstitution as a

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predictor of transplant success. The incidence of GVHD, particularly chronic GVHD in 30% of patients, highlights the ongoing challenge of managing post-transplant complications. Although the severity of chronic GVHD in our cohort was primarily mild to moderate, these findings underscore the need for continued research into more effective GVHD prophylaxis and management strategies [9]. The higher incidence of GVHD in patients receiving unrelated donor grafts suggests a potential area for improving donor matching protocols. Limitations of this study include its retrospective design and the variability in conditioning regimens and GVHD prophylaxis. Future prospective studies with larger sample sizes and standardized protocols could provide more definitive insights into optimizing BMT outcomes and minimizing complications. Overall, this study supports the continued use of BMT in treating pediatric ALL and highlights areas for further research to enhance patient care [10].

Conclusion

Bone marrow transplantation continues to be a vital treatment option for pediatric patients with high-risk or relapsed ALL. This study demonstrates promising long-term survival rates, with manageable complications related to GVHD and immune reconstitution. Ongoing research is needed to refine transplant protocols and improve outcomes for this vulnerable patient population.

Acknowledgment

None

Conflict of Interest

None

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