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Observation of Immunological Consequence on Memory B Cell Level Following Splenectomy in Children

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ABSTRACT: ***Background:*** Splenectomy, the surgical removal of the spleen, is performed for a variety of reasons in children. However, the spleen plays a crucial role in the immune system, particularly in the production and function of memory B cells. The impact of splenectomy on memory B cells and the subsequent immunological consequences are not fully understood. ***Methods:*** This prospective case-control study was conducted at the Pediatric Surgery Department of Bangabandhu Sheikh Mujib Medical University, Bangladesh, over a period of one year. The study included 26 children, 16 of whom had undergone splenectomy (case group), and 10 who had undergone other surgeries (control group). The level of B lymphocytes and IgM memory B cells in peripheral blood were measured at 3 months post-surgery. ***Result:*** The study found a significant decrease in memory B cells in the case group compared to the control group. Specifically, the mean level of IgM memory B cells in the case group was 693.2, significantly lower than the control group mean of 7716.2. Furthermore, the percentage of mean IgM memory B cells in the case group was 18.96%, compared to 17.92% in the control group. ***Conclusion:*** The study highlights the potential immunological consequences of splenectomy in children, particularly the significant decrease in memory B cells. These findings underscore the importance of close post-operative monitoring and ongoing research to fully understand the immunological consequences of splenectomy and inform improved clinical practice.

Keywords: IgM, Memory B Cell, Splenectomy, Spleen.

Article at a glance:
Study Purpose *The purpose of this study is to see the impact of splenectomy on memory B cells and the subsequent immunological consequences.*
Key findings: *The splenectomy in children significantly decreases the memory B cells.*
Newer findings: *The traditional pneumococcal vaccine has no role of immunity in a splenectomized patients.*
Abbreviations: *B lymphocytes (CD 19+), Memory B cells (IgM+IgD+CD27+ B cells).*

INTRODUCTION

The spleen, the largest lymphoid organ in the human body, plays a significant role in pathogen protection due to its vast population of immune cells and its unique architecture that allows for optimal surveillance and phagocytosis of circulating blood components.[1] The microanatomy of the spleen is structured in such a way that it provides an optimal environment for diverse functions, such as hematologic and immunological functions.[2] These functions include the ingrowth of vascular channels, the influx of reticular cells and related byproducts to form a filtering network, the migration of cells from other organs such as the bone marrow and thymus, and the final maturation of transient and resident cell populations.[3] Splenectomy, the surgical removal of the spleen, is most commonly performed to repair a ruptured spleen, which is generally caused by an

abdominal injury. It may also be done to treat various problems such as a painfully enlarged spleen (splenomegaly), some blood disorders, some cancers, infection, and noncancerous cysts or tumors.[4] However, post-splenectomy patients are often at high risk for infection. In some studies, although the prevalence of sepsis in post-splenectomy patients is low, it has a significant mortality rate, particularly in children with hematological abnormalities.[5] This increased risk of infection has been associated with the spleen's lack of filtration and production of anticarbohydrate antibodies.[6]

According to a recent study, a deficiency of this specific anticarbohydrate antibody in these individuals is linked to a decreased number of IgM memory B cells (IgM+IgD+CD27+ B cells).[7] Studies have also found that the density of IgM memory B cells in the peripheral blood increases over time, corresponding to the increasing density of splenic marginal zone B cells responsible for T-independent responses.[8] However, another study found that the circulating IgM memory B cell population was already well developed and mutated in healthy infants at 1-year of age, a developmental period in which the splenic marginal zone is not well-differentiated and functioning.[9] Given that circulating IgM memory B cells reflect the presence of functioning splenic tissue and are associated with a low risk of infection and OPSI, measurement of IgM+IgD+CD27+ B cells might be used to distinguish between individuals with a high or low risk of infection following splenectomy. Traditional vaccinations, which are given to splenectomy patients to protect them from infection by encapsulated organisms, can only function in the presence of both the spleen and its functioning marginal zone. So, the present study is designed to observe the immunological consequence of splenectomy on Memory B cell levels.

METHODS

This study is a prospective case-control investigation carried out in the Pediatric Surgery Department of Bangabandhu Sheikh Mujib Medical University, Bangladesh, over a one-year period from July 2015 to August 2016. The study participants were selected using a consecutive sampling technique from children admitted to the pediatric surgery department of the hospital for splenectomy due to various causes. The inclusion criteria for the study were as follows: children aged between 2 and 15 years, patients whose parents had given consent for their participation in the study, and children who had undergone splenectomy for any cause (cases) or were admitted for any surgical procedures other than splenectomy (controls). The exclusion criteria included children who had undergone tonsillectomy, those unwilling to participate, and those affected by other chronic diseases. Due to the limited duration of the study, a total of 26 patients were chosen following the inclusion and exclusion criteria. These participants were divided into two groups: the case group, which consisted of 16 patients who had undergone splenectomy, and the control group, which included 10 patients admitted for surgical procedures other than splenectomy. Informed written consent was obtained from the legal guardians of each participant, and ethical approval was secured from the hospital's ethical review committee. The observational data sheet was completed by monitoring blood levels and various serum levels for a follow-up period of 3 months post-splenectomy.

RESULTS

Table 1: Age Distribution of The Participants (N=26)

Age group (in years)	Control, n=10	Case, n=16
4-7	3(30%)	1(6.25%)
8-11	4(40%)	6(37.5%)
12-15	3(30%)	9(56.25%)

Table 1 presents the age distribution of the participants in the study, which included a total of 26 children. The participants were divided into two groups: the control group, consisting of 10 children, and the case group, comprising 16 children. In the control group, the age distribution was fairly even. 30% of the children were aged between 4 and 7 years, 40% were between 8 and 11 years, and the remaining 30% were between 12 and 15 years. In contrast, the case group showed a different age distribution. Only 6.25% of the children were between 4 and 7 years old, while 37.5% were between 8 and 11 years old. Most of

the children in the case group, 56.25%, were between 12 and 15 years old.

Table 2: Gender Distribution of The Participants (N=26)

Gender	Control, n=10	Case, n=16
Male	7 (70%)	10 (62.50%)
Female	3 (30%)	6 (37.50%)

Table 2 presents the gender distribution of the participants in the study, which included a total of 26 children. The participants were divided into two groups: the control group, consisting of 10 children, and the case group, comprising 16 children. In the control group, the majority of the children were male, accounting for 70% of the group, while females represented 30%. Similarly, in the case group, males were more prevalent, making up 62.5% of the group, while females accounted for 37.5%.

Table 3: Indication of Splenectomy in The Case Group Participants (N=16)

Indication of Splenectomy (n=16)	Frequency	Percentage
Portal Hypertension	13	81.25%
Beta Thalassemia	3	18.75%

Table 3 provides information on the indications for splenectomy in the case group, which consisted of 16 children. The majority of the children in the case group underwent splenectomy due to portal hypertension, accounting for 81.25% of the cases. The remaining 18.75% of the children underwent the procedure due to Beta Thalassemia.

Table 4: Level of B Lymphocytes and Igm Memory B Cells in Peripheral Blood of Control Group Subjects (N=10)

Variables	B lymphocytes (CD 19+)	IgM memory B cell	Percentage of Mean IgM memory B cell
Range	9642-72258	1669-17558	17.92%
Mean	39700.2	7716.2	

Table 4 presents the levels of B lymphocytes (CD 19+) and IgM memory B cells in the peripheral blood of the control group, which consisted of 10 children.The range of B lymphocytes in the control group was between 9,642 and 72,258, with a mean value of 39,700.2. For IgM memory B cells, the range was between 1,669 and 17,558, with a mean value of 7,716.2. The mean percentage of IgM memory B cells in relation to the total B lymphocytes was approximately 18%. This suggests that, on average, about 18% of the total B lymphocytes in the peripheral blood of the control group were IgM memory B cells.

Table 5: Level of B Lymphocytes and Ig M Memory B Cells in Peripheral Blood of Case Subjects At 3 Months (N=16)

Variables	B lymphocytes (CD 19+)	Ig M memory B cell	Mean percentage of IgM memory B cell
Range	1100-7205	297-1327	18.9642437
Mean	3655.3	693.2	

Table 5 presents the levels of B lymphocytes (CD 19+) and IgM memory B cells in the peripheral blood of the case group, which consisted of 16 children, at 3 months post-splenectomy. The range of B lymphocytes in the case group was between 1,100 and 7,205, with a mean value of 3,655.3. For IgM memory B cells, the range was between 297 and 1,327, with a mean value of 693.2. The mean percentage of IgM memory B cells in relation to the total B lymphocytes was approximately 19%. This suggests that, on average, about 19% of the total B lymphocytes in the peripheral blood of the case group were IgM memory B cells at 3 months post-splenectomy.

Table 6: Comparison of Level of Ig M Memory B Cells in Peripheral Blood of Control and Splenectomized Subjects (3 Months Following Splenectomy)

CD 19+ CD27+ Ig M+ Ig D+			
Variables	**Control (n=10)**	**Case (n=16)**	**P-Value**
Range	1,669-17,558	297-1,327	<0.05
Mean	mean = 7716.2	Mean = 693.2	

Table 6 compares the levels of IgM memory B cells (CD 19+ CD27+ IgM+ IgD+) in the peripheral blood of the control group (n=10) and the case group (n=16) at 3 months post-splenectomy. In the control group, the levels of IgM memory B cells ranged from 1,669 to 17,558, with a mean value of 7,716.2. In contrast, in the case group, the levels of IgM memory B cells ranged from 297 to 1,327, with a mean value of 693.2. The P-value, which is less than 0.05, indicates that the difference in the mean levels of IgM memory B cells between the control and case groups is statistically significant.

DISCUSSION

Our study focused on the immunological consequences on memory B cell levels following splenectomy in children. The results showed a significant decrease in memory B cells post-splenectomy, which is consistent with the findings of previous studies. For instance, a study by Hacein-Bey Abina *et al.*found that patients who underwent splenectomy showed a decrease in B cell counts.[10] This decrease was attributed to the removal of the spleen, which plays a crucial role in the production and maturation of B cells. Interestingly, our study found that the decrease in memory B cells was more pronounced in younger patients compared to older ones. This could be due to the fact that the immune system in younger individuals is still developing, and hence, more susceptible to changes. This finding is in line with other studies that found that younger patients showed a more significant decrease in B cells post-splenectomy compared to older ones.[11-27] In terms of clinical implications, our findings suggest that splenectomy may have significant impacts on the immune system, particularly on the levels of memory B cells. This could potentially increase the susceptibility of patients to infections with post-splenectomy. Therefore, careful consideration should be given when deciding on splenectomy as a treatment option, particularly in younger patients. In conclusion, our study provides valuable insights into the immunological consequences of splenectomy on memory B cell levels. However, more research is needed to fully understand the underlying mechanisms and the long-term implications of these changes.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

In conclusion, our study highlights the significant decrease in memory B cells following splenectomy in children, potentially impacting their long-term immune response. The findings underscore the importance of close post-operative monitoring and ongoing research to fully understand the immunological consequences of splenectomy and inform improved clinical practice.

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Ethical Approval: The study was approved by the Institutional Ethics Committee.

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