Cureus

Open Access Original Article

DOI: 10.7759/cureus.52692

Descriptive Characteristics of Multiple Myeloma Patients in King Abdulaziz Medical City National Guard

Review began 10/14/2023
Review ended 01/13/2024
Published 01/21/2024

Sultan Alqahtani [1, 2], Lama Alyabis [3], Hissah Alyabis [3], Nouf Al Qurashi [3], Rose Almadi [3], Majd Alsoman [3], Mohsen Alzahrani [4]

1. Department of Basic Medical Sciences, King Saud Bin Abdulaziz University for Health Sciences, College of Medicine, Riyadh, SAU 2. Research, King Abdullah International Medical Research Center (KAIMRC), Riyadh, SAU 3. College of Medicine, King Saud Bin Abdulaziz University for Health Sciences, Riyadh, SAU 4. Department of Oncology, Division of Stem Cell Transplantation and Cellular Therapy, King Abdulaziz Medical City, Riyadh, SAU

Corresponding author: Sultan Alqahtani, qahtanis@ksau-hs.edu.sa

Abstract

Background

Multiple myeloma (MM) is a hematological malignancy characterized by the production of monoclonal immunoglobulin. It is the second-most common hematological malignancy. The survival rate varies depending on age at diagnosis, comorbidities, and treatment. This study aims to assess the prevalence of clinical and laboratory characteristics among multiple myeloma patients.

Methods

This is an observational study of multiple myeloma patients who were admitted to King Abdulaziz Medical City - National Guard between January 2015 and December 2020. Patient records were reviewed to derive clinical and laboratory characteristics. Descriptive data analysis and survival analysis were obtained using SPSS.

Results

Our study included 151 patients, 95 of whom were males and 56 were females, and the mean age of diagnosis with MM was 62.6 (SD = 13.4). Among 151 MM patients, the most common clinical signs were bone lesions and renal disease, with a percentage of 66.9% and 46.4%, respectively. Death rates throughout the time of study conduction were 19.2%, accounting for 29 patients, and the median overall survival was 5.1 years with a 95% confidence level. Testing the association between survival rates and gender showed that death rates in females were significantly higher than in males (p-value = 0.023). Patients with anemia had a significantly higher hazard ratio in both unadjusted and adjusted analyses (aHR = 2.61; 95% CI = 1.21-5.65).

Conclusion

There was a relationship between survival and gender, which suggests a protective factor favoring the male gender. Clinical and laboratory characteristics, including bone marrow lesions, anemia, and renal disease, were the initial presentation; thus, a detailed history focused on symptoms should be taken when any of these symptoms are reported.

Categories: Hematology
Keywords: laboratory characteristics, clinical characteristics, mortality rate, prevalence, multiple myeloma

Introduction

Multiple myeloma (MM) is a cancer of plasma cells, a type of immune cell found in the bone marrow [1]. Plasma cells produce antibodies, also known as immunoglobulins, to help the body fight infection and disease. In MM, the cancerous plasma cells grow out of control and produce an excess of monoclonal immunoglobulins, which are abnormal antibodies [2]. These antibodies do not function properly and can accumulate in the body, leading to a range of symptoms and complications. MM is typically diagnosed through a combination of laboratory tests and imaging studies. The presence of high levels of monoclonal immunoglobulins in the blood or urine, as well as abnormal plasma cells in the bone marrow, can be used to diagnose MM [3]. Other diagnostic tests may include imaging studies, such as X-rays or PET scans, to look for bone lesions or other signs of MM [2].

Treatment for MM typically involves a combination of chemotherapy, targeted therapies, and stem cell transplantation. The specific treatment plan will depend on the individual patient and the stage of their disease, as well as on molecular analysis that determines the risk to help control the growth of the cancerous

plasma cells and alleviate symptoms [1]. In some cases, MM can be put into remission, but it is typically considered a chronic disease that requires ongoing treatment [4].

MM is a relatively uncommon cancer, accounting for about 1% of all cancers. It is common in people over the age of 65, and it is more common in men than in women [5]. According to estimates, there is a 1% annual risk of developing MM or a condition that is associated with it [5]. One of the most widespread pre-malignancies, smoldering myeloma, has a higher risk of transforming into MM. Monoclonal gammopathy of undetermined significance (MGUS) affects 3% of white people 50 years of age or older and nearly twice as many African Americans [6]. Several clinical and laboratory characteristics are commonly seen in patients with MM, including elevated levels of monoclonal immunoglobulins in the blood or urine, anemia, bone lesions, hypercalcemia, and kidney problems [4].

MM can cause anemia, which is an underproduction of red blood cells (RBC) due to excessive plasma cells in the bone marrow that can lead to symptoms such as fatigue, shortness of breath, and weakness. High levels of calcium in the blood owing to MM can lead to a condition known as hypercalcemia that can potentially cause thirst, fatigue, and confusion. Furthermore, MM can cause lytic bone lesions, or areas of abnormal bone growth, which can lead to bone pain and a higher risk of fractures. MM can also cause kidney issues and neurological symptoms, including weakness or even numbness in some cases. It is noteworthy to note that not all patients with MM will experience all of these clinical and laboratory characteristics, while the specific symptoms and complications will depend on the individual patient and the stage of their disease [3].

As people age, their risk of developing multiple myeloma rises. A high dietary intake of green vegetables and seafood has been linked to a lower risk of the disease, whereas obesity has consistently been linked to an increased risk of multiple myeloma [6]. The etiologic causes of white people having higher rates of multiple myeloma than African Americans have not been sufficiently researched [7]. The research identified that the African American population has a higher risk of developing MM than Caucasians. While these variables may be linked to either an increased or decreased risk of multiple myeloma, it is crucial to remember that other variables can influence a person's risk of getting the condition. Exposure to specific chemicals, radiation exposure, and specific inherited genetic abnormalities are other possible risk factors for multiple myeloma [7].

MM is not considered to be a genetic disease, but research has shown that there is a slightly higher risk of developing MM in individuals with a family history of the disease [2]. This increased risk is thought to be due to a combination of genetic and environmental factors. Smoldering myeloma is a precancerous condition that alters certain proteins in the blood and/or increases plasma cells in the bone marrow, but it does not cause symptoms of the disease. MGUS is a condition in which a person has an abnormal protein called a monoclonal protein in their blood [3]. It is considered to be a precursor to MM and is often asymptomatic. People with MGUS have a slightly increased risk of developing MM, as well as other types of cancer, such as Waldenström macroglobulinemia and chronic lymphocytic leukemia [3]. It is important to note that the majority of cases of MM occur in individuals without a family history of the disease. Therefore, having a family member with MM does not necessarily mean that a person will develop the disease [1]. However, it may be advisable for individuals with a family history of MM to discuss their risk with a healthcare provider and consider undergoing regular screenings for early detection [5].

The survival rate for multiple myeloma varies depending on various factors, including the stage of the disease at diagnosis, the patient's age and overall health, and the treatment options available. According to the American Cancer Society, the five-year survival rate for multiple myeloma is about 50%, meaning about half of all people diagnosed with multiple myeloma are still alive five years after their diagnosis [8]. However, it is important to note that survival rates are estimates and can vary widely depending on the individual circumstances of each case. The prognosis for multiple myeloma has improved significantly in recent years due to advances in treatment options [9]. Newer treatments, such as targeted therapies and immunotherapies, have shown promising results in improving survival rates and quality of life for people with multiple myeloma. Individuals with multiple myeloma need to work closely with their healthcare team to determine the most appropriate treatment plan for their specific situation [10].

This study aims to assess the clinical and laboratory characteristics of patients suffering from MM in King Abdulaziz Medical City-National Guard.

Materials And Methods

This is an observational study of multiple myeloma patients who were admitted to King Abdulaziz Medical City - National Guard, from January 2015 to December 2020. Patient records were reviewed to derive clinical and laboratory characteristics. Descriptive data analysis and survival analysis were obtained using SPSS (IBM Corp., Armonk, NY).

Study design, area, and settings

This is an observational retrospective cross-sectional study of patients admitted to King Abdulaziz Medical City - National Guard Governmental Hospital in Riyadh, specifically at the hematology and oncology

department. KAMC-R, a tertiary care center, is one of the most distinguished hospitals in Saudi Arabia that receives consultations nationwide. The study underwent ethical approval from the ethical review committee of King Saud bin Abdulaziz University for Health Sciences. The Institutional Review Board (IRB) approved the study with the number SP20/263/R. This approval allowed us to proceed with research in compliance with ethical guidelines and ensured the protection of participants' rights and welfare.

Identification of study participants

This study included all multiple myeloma patients who were admitted to King Abdulaziz Medical City in Riyadh over a half-decade period from January 2015 to December 2020. The International Myeloma Working Group (IMWG) criteria were used to diagnose the patients. Both males and females of all group ages and nationalities who were diagnosed with multiple myeloma from 2015 to 2020 were included in this study. Those with plasma cell reactions to connective tissue disorder, liver disease, carcinoma, and chronic infection were excluded from the study. A simple random sampling technique was applied to select the diseased patients [9].

Based on our exclusion criteria, patients who were diagnosed with plasma cell reactions to connective tissue disorders, liver diseases, carcinomas, and chronic infections were excluded because they were not the target of this study.

This study aims to obtain an estimation of the prevalence of certain characteristics in multiple myeloma patients. Worldwide, the five-year limited-durability prevalence of multiple myeloma is nearly 230,000 patients [11]. In the United States, an estimated 30,330 people were newly diagnosed with multiple myeloma, resulting in 12,650 deaths [5]. Annually, about 20 to 30 patients with multiple myeloma get admitted to King Abdulaziz Medical City in Riyadh. With a marginal error of 5%, a confidence level of 95%, and a response distribution of 50%, the calculated sample size was 152.

Data collection process

The data were collected from King Abdulaziz Medical City (KAMC) files of patients diagnosed with multiple myeloma. The main predictors were abstracted from patients' files using a data collection sheet that includes all the patients' demographics like age, gender, nationality, and laboratory findings. The values of laboratory tests were obtained from the tests performed when the patient first presented to the hematology/oncology department. Moreover, clinical data such as date of diagnosis, presenting symptoms, and treatment were used to derive the outcome variable as an estimation of the prevalence of the mentioned predictors among MM patients. Data regarding cytogenic abnormalities (FISH data) were not included. Patient confidentiality was conserved by replacing the MRI number with a serial number. Only investigators have access to the secure files where patients' data is kept.

Data were scored as high, normal, and low. Dates of birth, diagnosis, and death/last seen were used in statistical analysis. The normal range established for all variables mentioned in Table *1* served as the basis for data points. Within the normal range, values were considered normal. Any value below the normal range was considered low, while any value above the normal range was considered high. These definitions ensured that we accurately assessed and categorized the data.

Variables	Normal range
Ca	2.1–2.55 mmol/L
BUN	3–9.2 mmol/L
Hgb	135–180 g/L
Hct	0.42–0.54 L/L
Wbc	4.00–11.00 × 10^9/L
Plt	150–400 × 10^9/L
IgG	7.51–15.60 g/L
IgA	0.82–4.53
IgM	0.46–3.04 g/L
Free kappa	19.40 mg/L
Free Lambda	5.71–26.30 mg/L
Free kappa/Lambda ratio	0.26–1.65

TABLE 1: Normal range of variables

Data analysis

Our data have been entered by the co-investigators using Microsoft Excel (Microsoft® Corp., Redmond, WA) and analyzed using SPSS (IBM Corp., Armonk, NY) [12]. We presented categorical variables as frequencies and percentages, and numerical variables as mean ± standard deviation. We used the Pearson Chi-square test to assess the relationship between MM characteristics and the various predictors. The Kaplan-Meier test was used to estimate the survival time for MM patients in years. Crude and adjusted hazard ratios were computed to identify the factors that are related to survival while adjusting for other relevant covariates. Univariate analysis was done to show the distribution of the different variables, which include gender, age, and survival. Multivariate analysis was done by computing crude and adjusted hazard ratios using the Cox proportional hazard model. All P-values were two-tailed and a p-value of <0.05 is considered to be statistically significant.

Results

A total of 151 patients were diagnosed with MM in NGHA from 2015 to 2020, with 95 (62.9%) being males and 56 (37.1%) being females. In Table *2*, we categorized our patients into four groups according to their age, with the youngest ⩽ 50 accounting for 14.6%, 21.9% of the patients between 51 and 60, almost 29.1% for those who were 61-70 years old, and the peak range was 71 years old or older, with a percentage of 34.4%. The mean age of diagnosis was determined to be 62.6 with a standard deviation of 13.4 (range = 32 to 95 years of age). The majority of our sample was from Saudi Arabia (90.2%), while the rest (9.8%) were from other countries. Death rates throughout the time of study conduction were 19.2%, accounting for a total of 29 patients, and the median overall survival from the time of myeloma diagnosis was 5.1 years with a 95% confidence level.

Variable		Frequency (percentage)
Gender	Female	56 (37.1%)
	Male	95 (62.9%)
Age	≤50	22 (14.6%)
	51–60	33 (21.9%)
	61–70	44 (29.1%)
	71+	52 (34.4%)
Survival	Alive	122 (80.8%)
	Dead	29 (19.2%)

TABLE 2: Characteristics of patients having multiple myeloma

The median overall survival from the time of myeloma diagnosis was 5.1 years, with a 95% confidence level. The median follow-up period is every three months. To determine the median overall survival time using the Kaplan-Meier test, we need specific data on survival times for individuals in a study or population. Without the actual data, it is not possible to provide an accurate median overall survival time. The Kaplan-Meier test is a statistical method used to estimate survival probabilities over time, but the specific median value can only be calculated with the actual survival time data. The survival curve for these patients is shown in Figure *1*.

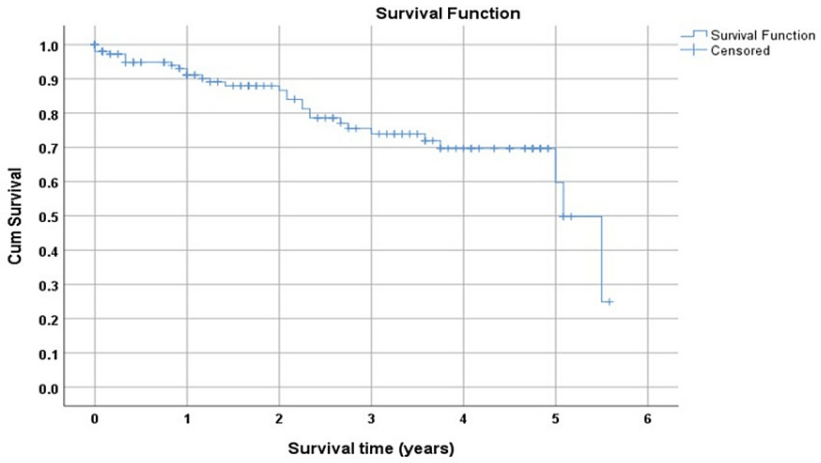

FIGURE 1: The Kaplan Meier curve for the multiple myeloma patients

The characteristics of laboratory results are listed in Table *3*. Regarding lab results, none of the patients had high levels of hemoglobin, while 83% showed up to have low levels. For WBCs and platelet counts, most of the results were normal. However, 49.6% of the patients' calcium levels were normal, 28.5% were low, and 22% were high. Concerning the immunoglobulin and light chains, subtypes of myeloma, the most common type was IgG, 106 out of 147 (46.5%), the kappa chain, 96 out of 147 (65.8%), and the lambda chain, 46 out of 147 (31.5%).

Variable	N	Alive, N = 122 frequency (percentage)	Dead, N = 29 frequency (percentage)	p-value
Gender	151			0.025
Female		40 (32.8%)	16 (55.2%)	
Male		82 (67.2%)	13 (44.8%)	
Age	151			0.3
≤50		16 (13.1%)	6 (20.7%)	
51–60		29 (23.8%)	4 (13.8%)	
61–70		38 (31.1%)	6 (20.7%)	
71+		39 (32.0%)	13 (44.8%)	
Nationality	132			0.5
Non-Saudi		12 (11.1%)	1 (4.2%)	
Saudi		96 (88.9%)	23 (95.8%)	
Hb	143			0.6
Low		96 (82.8%)	24 (88.9%)	
Normal		20 (17.2%)	3 (11.1%)	
WBC count	141			>0.9
High		14 (12.3%)	3 (11.1%)	
Low		32 (28.1%)	9 (33.3%)	
Normal		68 (59.6%)	15 (55.6%)	
Platelets count	139			0.9
High		9 (8.0%)	1 (3.8%)	
Low		32 (28.3%)	7 (26.9%)	
Normal		72 (63.7%)	18 (69.2%)	
Calcium levels	122			>0.9
High		22 (22.7%)	5 (20.0%)	
Low		27 (27.8%)	8 (32.0%)	
Normal		48 (49.5%)	12 (48.0%)	
Chemotherapy	148	93 (78.2%)	21 (72.4%)	0.5
Radiotherapy	151	11 (9.0%)	1 (3.4%)	0.5
BMT surgery	150	50 (41.3%)	11 (37.9%)	0.7
Anemia	150	40 (33.1%)	17 (58.6%)	0.011
Bortezomib	144	21 (17.8%)	5 (19.2%)	0.8

TABLE 3: Characteristics of multiple myeloma patients by survival status

The most common immunoglobulins were IgG, found in 72.1% of individuals and Kappa chain, found in 65.8% of the patients (Figure *2*). The clinical characteristics are shown in Figure *3*. Among 151 MM patients, the most common signs were bone lesions and renal disease, with a percentage of 66.90% and 46.40%, respectively. The third most common manifestation was anemia, which was present in 38% of patients. Almost half of the patients had comorbidities, as the prevalence of diabetes was 50.3% and hypertension was 48.3%. The treatment of choice for most patients was chemotherapy (77%), followed by autologous bone marrow transplant (40.7%). There was no allogeneic transplant. The majority of the patients had one

autologous transplant and three patients had a double transplant. Only 12 out of 151 (7.9%) patients had radiotherapy treatment. Among the patients who underwent chemotherapy, the most common regimens were VCd (39.3%) and VRd (35%). Males had a lower hazard ratio as compared to females but this difference disappeared in the adjusted analysis. Patients with anemia had a significantly higher hazard ratio in both unadjusted and adjusted analyses (aHR = 2.61; 95% CI = 1.21-5.65) (Table *4*).

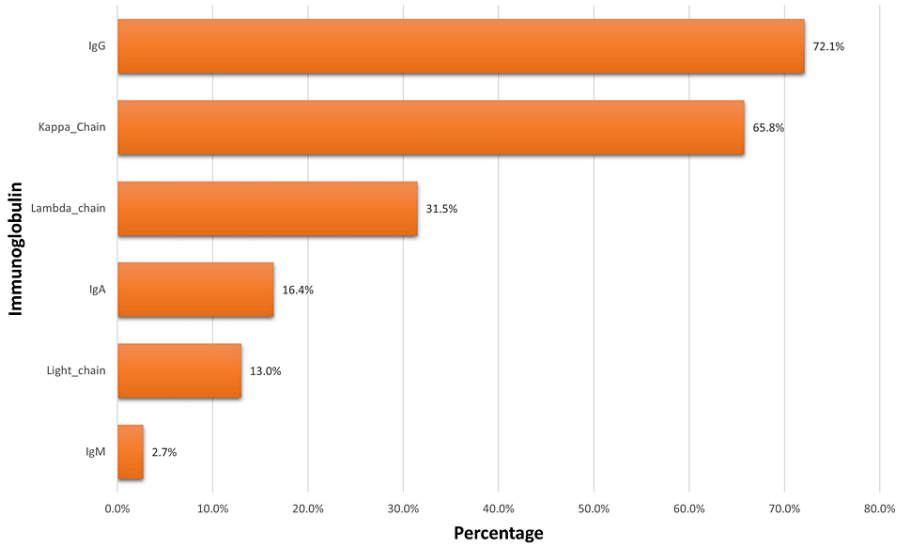

FIGURE 2: The laboratory findings of our patient's immunoglobulins type

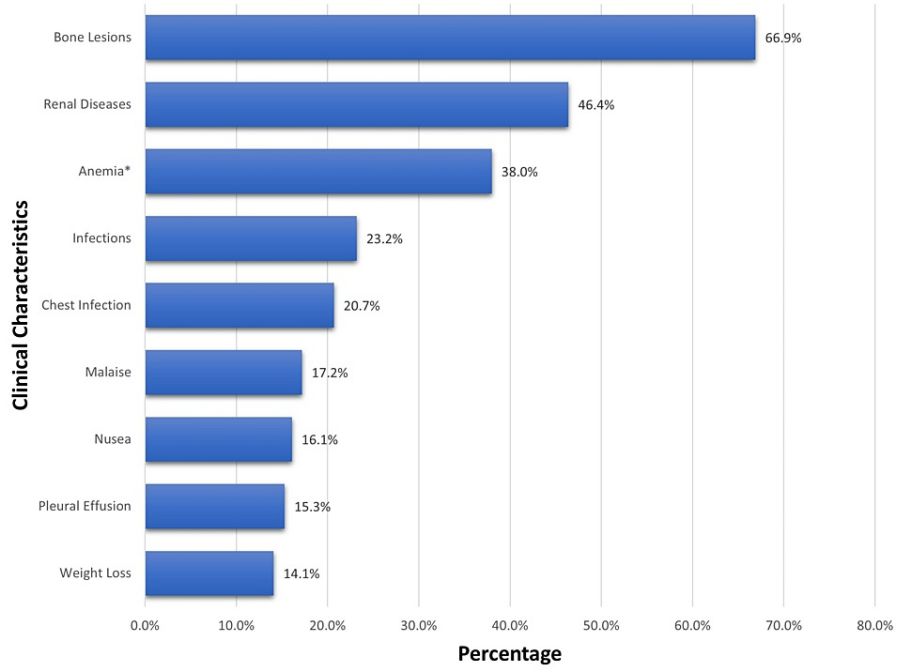

FIGURE 3: The clinical characteristics of the participants included in this study

Variable	Univariate		Multivariate	
	Crude HR	95% CI	Adjusted HR	95% CI
Gender				
Male	0.45	0.21–0.94	0.53	0.25–1.15
Female	1		1	
Anemia				
Yes	2.92	1.36–6.27	2.61	1.21–5.65
No	1		1	

TABLE 4: Crude and adjusted hazard ratios

Discussion

Over the years, various modifications have been made to the embryo transfer medium in order to improve live birth and clinical pregnancy rates [9]. Our study focuses on the modification that involves the use of protein supplementation, with albumin being the most commonly used protein in embryo transfer mediums [10]. It also acts as a lubricant, facilitating easy embryo handling and preventing embryo adherence to the culture dish. In this study, the embryos were cultured with 10 mg/mL of recombinant human albumin (rHA) and a lower concentration of hyaluronic acid (HA) in G-2™, Vitrolife, and compared to the EmbryoGlue® medium.

The objective of the present study was achieved and illustrates that the use of EmbryoGlue® significantly improved the clinical pregnancy rate compared to the standard treatment group [11]. This finding is consistent with previous studies by Schoolcraft et al. and Balaban et al., which have also reported higher clinical pregnancy rates associated with the use of EmbryoGlue®. Additionally, Adeniyi et al. [10] found that EmbryoGlue® enhanced clinical pregnancy and implantation rates in both fresh and frozen-thawed embryo transfer cycles [12]. The authors suggested that the high viscosity of EmbryoGlue® may physically protect embryos treated with assisted hatching during frozen-thawed cycles.

The mechanism of action of hyaluronan in promoting embryo implantation may be attributed to several factors. Hyaluronan can bind to specific cell surface receptors, creating a favorable environment for embryo attachment and implantation. It also absorbs and retains water, leading to increased hydration and lubrication of tissues, which may aid in creating a conducive environment for embryo implantation by providing physical support, reducing friction, and facilitating embryo movement through the reproductive tract [13].

The live birth rate, a crucial measure of success in fertility treatments, was significantly higher in the EmbryoGlue® group compared to the standard treatment group in this study. This outcome aligns with the ultimate goal of achieving a healthy pregnancy resulting in the birth of a healthy baby, as previously highlighted by Wang et al. The live birth rate reflects the percentage of embryo transfers that resulted in at least one live birth, making it a clinically meaningful measure of success in assisted reproductive treatments.

Over the years, various modifications have been made to the embryo transfer medium in order to improve live birth and clinical pregnancy rates [9]. Our study focuses on the modification that involves the use of protein supplementation, with albumin being the most commonly used protein in embryo transfer mediums [10]. It also acts as a lubricant, facilitating easy embryo handling and preventing embryo adherence to the culture dish. In this study, the embryos were cultured with 10 mg/mL of rHA and a lower concentration of HA in G-2™, Vitrolife, and compared to the EmbryoGlue® medium.

The objective of the present study was achieved and illustrates that the use of EmbryoGlue® significantly improved the clinical pregnancy rate compared to the standard treatment group [11]. This finding is consistent with previous studies by Schoolcraft et al. and Balaban et al., which have also reported higher clinical pregnancy rates associated with the use of EmbryoGlue®. Additionally, Adeniyi et al. [10] found that EmbryoGlue® enhanced clinical pregnancy and implantation rates in both fresh and frozen-thawed embryo transfer cycles [12]. The authors suggested that the high viscosity of EmbryoGlue® may physically protect embryos treated with assisted hatching during frozen-thawed cycles.

The mechanism of action of hyaluronan in promoting embryo implantation may be attributed to several factors. Hyaluronan can bind to specific cell surface receptors, creating a favorable environment for embryo

attachment and implantation. It also absorbs and retains water, leading to increased hydration and lubrication of tissues, which may aid in creating a conducive environment for embryo implantation by providing physical support, reducing friction, and facilitating embryo movement through the reproductive tract [13].

The live birth rate, a crucial measure of success in fertility treatments, was significantly higher in the EmbryoGlue® group compared to the standard treatment group in this study. This outcome aligns with the ultimate goal of achieving a healthy pregnancy resulting in the birth of a healthy baby, as previously highlighted by Wang et al. The live birth rate reflects the percentage of embryo transfers that resulted in at least one live birth, making it a clinically meaningful measure of success in assisted reproductive treatments.

Other studies, such as the one conducted by Adeniyi et al., have also reported positive outcomes with the use of hyaluronan-enriched embryo transfer medium in ICSI cycles. While the study found a significantly higher pregnancy rate in the group that used the hyaluronan-enriched medium, there were no significant differences in implantation rate, miscarriage rate, or live birth rate. These findings suggest that hyaluronan may primarily influence early pregnancy outcomes, such as pregnancy rates [14].

A study conducted by Fadhil et al. further supports the notion that EmbryoGlue® may improve pregnancy rates, particularly in women aged 35 and above [15]. The study found significantly higher pregnancy rates in subgroup AII (women aged 35 and above) who received EmbryoGlue® compared to subgroup BII, which received a conventional medium. In our study for patients aged <35 years, the clinical pregnancy rate was 62.3% in the standard treatment group and significantly higher at 71.7% in the embryo glue treatment group (p-value = 0.002).

It is essential to acknowledge that miscarriage rates were comparable between the EmbryoGlue® group and the standard treatment group in this study. Miscarriage rates can be influenced by various factors, such as maternal age, underlying medical conditions, and embryonic chromosomal abnormalities. As a result, these factors may have contributed to the lack of significant differences in miscarriage rates between the two groups.

Overall, the results of this study suggest that the use of EmbryoGlue® in IVF treatments may lead to significant improvements in biochemical pregnancy rate, clinical pregnancy rate, live birth rate, and multiple live birth rate compared to the standard treatment group. However, it is essential to consider the potential risks and benefits of using EmbryoGlue®, particularly the increased risk of multiple pregnancies.

As with any retrospective study, this study has certain limitations, which might introduce biases and hinder the establishment of causal relationships between the identified factors and live birth outcomes. Considering the retrospective nature, there was missing data from previous ART outcomes, so we could not analysed the same. Future prospective randomized controlled trials may be necessary to further validate and confirm these findings. Considering the retrospective nature, there was missing data from previous ART outcomes, so we couldn't analysed the same. Nevertheless, this study contributes valuable information on the potential benefits of using EmbryoGlue® in frozen embryo transfer cycles, providing a basis for further research and clinical decision-making in assisted reproductive treatments.

Conclusions

A thorough history focused on symptoms should be taken whenever any of these results or symptoms are reported to diagnose and treat the disease as quickly as possible. Clinical presentations like bone lesions, renal diseases, and anemia are often the only initial presentation in many patients. This study comprised individuals diagnosed with multiple myeloma for six years, with a sample size of 120. We recommend future research into multiple myeloma be done over a longer period of time with a larger sample size for a clearer understanding of the condition.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Sultan Alqahtani, Nouf Al Qurashi , Hissah Alyabis, Lama Alyabis , Rose Almadi , Majd Alsoman , Mohsen Alzahrani

Acquisition, analysis, or interpretation of data: Sultan Alqahtani, Nouf Al Qurashi , Hissah Alyabis, Lama Alyabis , Rose Almadi , Majd Alsoman , Mohsen Alzahrani

Drafting of the manuscript: Sultan Alqahtani, Nouf Al Qurashi , Hissah Alyabis, Lama Alyabis , Rose Almadi , Majd Alsoman , Mohsen Alzahrani

Critical review of the manuscript for important intellectual content: Sultan Alqahtani, Nouf Al Qurashi , Hissah Alyabis, Lama Alyabis , Rose Almadi , Majd Alsoman , Mohsen Alzahrani

Supervision: Sultan Alqahtani, Mohsen Alzahrani

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. King Abdullah International Medical Research Center issued approval SP20/263/R. The ethical approval was obtained from King Abdullah International Medical Research Center, Riyadh, Saudi Arabia, with approval number SP20/263/R. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Kumar SK, Rajkumar SV: The multiple myelomas - current concepts in cytogenetic classification and therapy. Nat Rev Clin Oncol. 2018, 15:409-21. 10.1038/s41571-018-0018-y
2. Boland E, Eiser C, Ezaydi Y, Greenfield DM, Ahmedzai SH, Snowden JA: Living with advanced but stable multiple myeloma: a study of the symptom burden and cumulative effects of disease and intensive (hematopoietic stem cell transplant-based) treatment on health-related quality of life. J Pain Symptom Manage. 2013, 46:671-80. 10.1016/j.jpainsymman.2012.11.003
3. Ramsenthaler C, Kane P, Gao W, Siegert RJ, Edmonds PM, Schey SA, Higginson IJ: Prevalence of symptoms in patients with multiple myeloma: a systematic review and meta-analysis. Eur J Haematol. 2016, 97:416-29. 10.1111/ejh.12790
4. Kyle RA, Therneau TM, Rajkumar SV, Larson DR, Plevak MF, Melton LJ 3rd: Long-term follow-up of 241 patients with monoclonal gammopathy of undetermined significance: the original Mayo Clinic series 25 years later. Mayo Clin Proc. 2004, 79:859-66. 10.4065/79.7.859
5. Kazandjian D: Multiple myeloma epidemiology and survival: a unique malignancy . Semin Oncol. 2016, 43:676-81. 10.1053/j.seminoncol.2016.11.004
6. Landgren O, Kyle RA, Pfeiffer RM, et al.: Monoclonal gammopathy of undetermined significance (MGUS) consistently precedes multiple myeloma: a prospective study. Blood. 2009, 113:5412-7. 10.1182/blood-2008-12-194241
7. Alexander DD, Mink PJ, Adami HO, Cole P, Mandel JS, Oken MM, Trichopoulos D: Multiple myeloma: a review of the epidemiologic literature. Int J Cancer. 2007, 120 Suppl 12:40-61. 10.1002/ijc.22718
8. El Husseiny NM, Kasem N, El Azeeim HA, Mattar MW: Multiple myeloma: a descriptive study of 217 Egyptian patients. Ann Hematol. 2014, 93:141-5. 10.1007/s00277-013-1849-3
9. Becker N: Epidemiology of multiple myeloma . Recent Results Cancer Res. 2011, 183:25-35. 10.1007/978-3-540-85772-3_2
10. Qian J, Jin J, Luo H, Jin C, Wang L, Qian W, Meng H: Analysis of clinical characteristics and prognostic factors of multiple myeloma: a retrospective single-center study of 787 cases. Hematology. 2017, 22:472-6. 10.1080/10245332.2017.1309493
11. Gerecke C, Fuhrmann S, Strifler S, Schmidt-Hieber M, Einsele H, Knop S: The diagnosis and treatment of multiple myeloma. Dtsch Arztebl Int. 2016, 113:470-6. 10.3238/arztebl.2016.0470
12. IBM Corp. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. (2013). Accessed: February 20, 2021: https://www.ibm.com/support/pages/downloading-ibm-spss-statistics-20.
13. Teras LR, DeSantis CE, Cerhan JR, Morton LM, Jemal A, Flowers CR: 2016 US lymphoid malignancy statistics by World Health Organization subtypes. CA Cancer J Clin. 2016, 66:443-59. 10.3322/caac.21357
14. Palumbo A, Anderson K: Multiple myeloma. N Engl J Med. 2011, 364:1046-60. 10.1056/NEJMra1011442
15. Blimark C, Holmberg E, Mellqvist UH, et al.: Multiple myeloma and infections: a population-based study on 9253 multiple myeloma patients. Haematologica. 2015, 100:107-13. 10.3324/haematol.2014.107714
16. Mehta J, Singhal S: Hyperviscosity syndrome in plasma cell dyscrasias . Semin Thromb Hemost. 2003, 29:467-71. 10.1055/s-2003-44554
17. Dimopoulos MA, Terpos E, Niesvizky R, Palumbo A: Clinical characteristics of patients with relapsed multiple myeloma. Cancer Treat Rev. 2015, 41:827-35. 10.1016/j.ctrv.2015.07.005
18. Kyle RA, Gertz MA, Witzig TE, et al.: Review of 1027 patients with newly diagnosed multiple myeloma . Mayo Clin Proc. 2003, 78:21-33. 10.4065/78.1.21
19. International Myeloma Working Group: Criteria for the classification of monoclonal gammopathies, multiple myeloma and related disorders: a report of the International Myeloma Working Group. Br J Haematol. 2003, 121:749-57.
20. Kleman A, Singavi A, Pommert L, et al.: A timeline of genetic variant enrichment: from multiple myeloma diagnosis to myeloma-associated myeloid malignancy. Blood Adv. 2023, 7:5549-53. 10.1182/bloodadvances.2022008953
21. Paradisi F, Corti G, Cinelli R: Infections in multiple myeloma . Infectious Disease Clinics. 2001, 15:373-84. 10.1016/S0891-5520(05)70151-3
22. Wang L, Jin FY, Li Y, Sun JN, Zhang JJ, Tang R, Zhong YP: IgA type multiple myeloma, clinical features, and prognosis. Chin Med J (Engl). 2018, 131:1249-50. 10.4103/0366-6999.231513
23. Howell D, Smith A, Appleton S, et al.: Multiple myeloma: routes to diagnosis, clinical characteristics and survival - findings from a UK population-based study. Br J Haematol. 2017, 177:67-71. 10.1111/bjh.14513

24. Bird JM, Owen RG, D'Sa S, et al.: Guidelines for the diagnosis and management of multiple myeloma 2011 . Br J Haematol. 2011, 154:32-75. 10.1111/j.1365-2141.2011.08573.x
25. Almueilo SH: Renal failure in patients with multiple myeloma . Saudi J Kidney Dis Transpl. 2015, 26:482-8. 10.4103/1319-2442.157327
26. Khalil SH, Padmos A, Ernst P, Clink HM: Multiple myeloma: a review of 92 cases at King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia. Ann Saudi Med. 1991, 11:642-6. 10.5144/0256-4947.1991.642
27. Mseddi-Hdiji S, Haddouk S, Ben Ayed M, et al.: [Monoclonal gammapathies in Tunisia: epidemiological, immunochemical and etiological analysis of 288 cases]. Pathol Biol (Paris). 2005, 53:19-25. 10.1016/j.patbio.2004.01.014
28. Talamo G, Farooq U, Zangari M, Liao J, Dolloff NG, Loughran TP Jr, Epner E: Beyond the CRAB symptoms: a study of presenting clinical manifestations of multiple myeloma. Clin Lymphoma Myeloma Leuk. 2010, 10:464-8. 10.3816/CLML.2010.n.080
29. Eda H, Santo L, David Roodman G, Raje N: Bone disease in multiple myeloma . Cancer Treat Res. 2016, 169:251-70. 10.1007/978-3-319-40320-5_14