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Electrophoretic Profile of Multiple Myeloma at the Biochemistry Laboratory of Dalal Jamm National Hospital

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Abstract

Introduction: Multiple myeloma (MM) is characterized by the abnormal proliferation of a plasma cell clone invading the bone marrow, with secretion of a monoclonal immunoglobulin (Ig), detectable by serum protein electrophoresis. The aim of our work was to study the electrophoretic profile of patients with MM. **Methods:** This is a retrospective descriptive and analytical study including 76 patients with MM, whose serum samples were received at the Biochemistry Department of the Dalal Jamm National Hospital during the period from January 1, 2021 to April 30, 2023. For each patient, we studied epidemiological data (age, sex, service) and biochemical variables (proteinemia, electrophoresis and serum protein immunofixation). **Results:** The mean age of our patients was 58 ± 10.24 years, with a sex ratio of 0.9, with a female predominance (52.6%). The majority of cohort (71.1%) were consulted as outpatients. Hyperproteinemia was observed in 27.6% of patients, with a mean average of 91.2 ± 25.2 g/L, while hypoalbuminemia was found in 43.4% of patients. A monoclonal peak was noted at the Serum protein electrophoresis (SPEP) in all patients in our series, 75% of whom were in the gamma zone and 22.4% in the beta zone. Immunofixation had objectified kappa-type IgG myeloma in the majority of patients (77.8%). **Conclusion:** Among the biological markers of MM, serum protein electrophoresis remains the most characteristic for detecting monoclonal immunoglobulin.

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Keywords

Multiple Myeloma, Monoclonal Ig, Serum Protein Electrophoresis, Immunofixation

1. Introduction

Multiple myeloma (MM) or Kahler's disease is a hematologic malignancy of the monoclonal gammopathy family, characterized by the proliferation of a plasma cell clone invading the bone marrow, with the secretion of a monoclonal immunoglobulin (Ig) [1].

It is the second most common hemopathy in the world after non-Hodgkin lymphomas (NHL), accounting for 10 and 15% of total hemopathies, or about 1 to 1.5% of total cancers [2]. In Senegal, the incidence of the disease is 0.52%, and the national estimate of its mortality shows an average of 50 deaths per year, or a mortality of 0.63% [2].

It is a rare pathology, mainly affecting elderly subjects, which explains why its incidence increases with the aging of the population [3].

Malignant plasma cell proliferation has repercussions on various levels, including biochemical and hematological proliferation, with serious consequences. Thus, in the management of MM, biochemical examinations such as Serum protein electrophoresis (SPEP) and immunofixation (IF) are essential for diagnosis as well as during patient follow-up [4].

A lot of research is being done on MM, aimed at improving patient care, and deepening knowledge of the biology of pathology.

Our study was carried out within that framework with the objective of studying the electrophoretic profile of patients with multiple myeloma in the Biochemistry Laboratory of the Dalal Jamm National Hospital (CHNDJ). It consisted of evaluating the concentration of proteins and protein fractions found and also identifying the type of monoclonal immunoglobulin at immunofixation.

2. Population and Methods

2.1. Population

The study involved 76 patients, all of whom underwent serum protein electrophoresis with the presence of a monoclonal peak. Of these patients, 27 went through serum protein immunofixation from January 2021 to April 2023 at the Biochemistry Department of Dalal Jamm Hospital in collaboration with the Clinical Hematology Department of the same hospital. Subjects whose information was incomplete or unusable were excluded from the study.

2.2. Methods

This was a retrospective study with a descriptive and analytical target. It involved

socio-demographic parameters, such as age, sex and origin of patients (outpatient or inpatient), as well as biological parameters: total serum protein assay (proteinemia), electrophoresis and serum protein immunofixation.

a) Sample collection and processing

Each patient had a blood sample taken from the crease of the elbow. The main condition was fasting for at least 12 hours. Whole blood is collected in a dry tube. The samples are then centrifuged at 4000 rpm for 5 minutes and the serum obtained was treated immediately or stored in the refrigerator at +4˚C for a maximum of 7 days, or at −20˚C.

b) Parameter dosing

Proteinemia: the principle of the assay is based on the Biuret colorimetric reaction, which makes it possible to highlight the peptide bonds of the proteins present in the serum. The staining reagent used is Gornall's reagent. In an alkaline environment, peptide bonds form a stained complex with copper ions (with a maximum absorption at 540 nm) which staining intensity is proportional to the protein concentration [5]. The Architect® c4000 controller (Abbott®) was used.

Serum protein electrophoresis: It is performed on agarose gel by the Hydrases 2 Scan® automaton (Sebia® Cedex, France), whose principle consists of the migration and separation of serum proteins, in alkaline buffer (pH = 9.2) on a gel. And densitometry (at 570 nm) gives a precise relative quantification of each individualized area.

Serum protein immunofixation is a qualitative immunochemical sensitive identification technique, which allows the visualization of different serum monoclonal Ig clones. The serum proteins are separated according to their agarose gel load. The Hydrases 2 Scan® PLC (Sebia® Cedex, France) was used.

c) Statistical analysis

The data was exported from Phoresis® software and then entered and used by Microsoft© Excel® 2016. They were analyzed using R software version 4.2.3.

3. Results

3.1. Characteristics of the Study Population

The mean age of our patients was 58 ± 10.24 years, with extremes ranging from 22 to 83 years. 36 patients (47.4%) were male, while 40 patients (52.6%) were female with a sex ratio of 0.9, thus showing a female predominance. According to age, the most represented were between 50 and 59 years old (40.80%), followed by those between 60 and 69 years old (27.60%), and more than half of the patients, 81.6%, were over 50 years old Figure 1.

The distribution of our population according to age groups and sex is shown in Figure 2, showing a male predominance at any age, except between 50 - 59 years old, where a female predominance was found with 24 patients against 7 patients of M sex.

By origin: The majority of patients were patients consulting on an outpatient basis (71.1%).

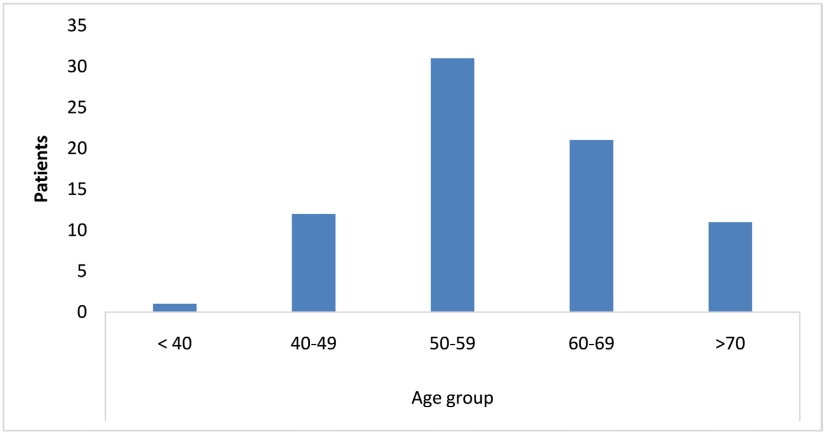

Figure 1. Distribution of patients by age groups.

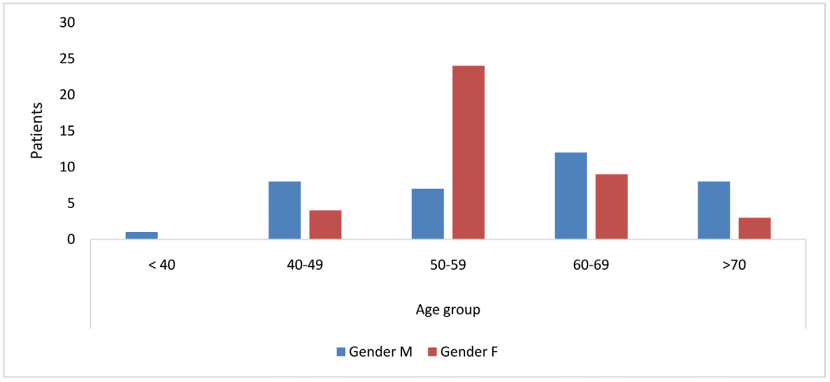

Figure 2. Distribution of patients by gender and age groups.

3.2. Proteinemia and Serum Protein Electrophoresis

Five protein fractions were found SPEP. Depending on their migration from the cathode to the anode, we have respectively: Albumin, α-1 globulin, α-2 globulin, β-globulin, and γ-globulin. Their mean value and standard deviation are shown in **Table 1**.

Table 1. Mean value and standard deviation of the proteinemia, the different protein fractions found at the EPS and the A/G ratio.

	Means and Standard Deviation	Usual Values
Total protein (g/L)	91.22 ± 25.29	65 - 80
Albumin (g/L)	29.62 ± 11.11	35 - 45
α-1 globulin (g/L)	1.97 ± 0.67	2.1 - 3.5
α-2 globulin (/L)	7.40 ± 2.35	5.1 - 8.5
β-globulin (g/L)	11.51 ± 13.25	5 - 12
γ-globulin (g/L)	40.71 ± 31.38	8.0 - 13.5
A/G ratio	0.63 ± 0.39	1.2 - 1.8

Three main abnormalities were noted:

- Proteinemia

The mean serum protein concentration in our series was 91.2 ± 25.2 g/L, with extremes ranging from 50.7 to 157.7 g/L. Hyperproteinemia was found in 21 patients, or 27.6%, while hypoproteinemia was found in 26 patients or 34.2% of our study population.

- Albuminemia

The mean albumin level in our series was 29.6 ± 11.11 g/L, with extremes ranging from 2.6 to 51.5 g/L. Hypoalbuminemia was found in 43.40% of patients, of whom 18.40% were severe, with an albuminemia value of less than 20 g/L.

- Characteristics of the monoclonal component

The monoclonal-like peak was found in all patients in our series.

The distribution of patients according to the migration area of the monoclonal peak is shown in Figure 3.

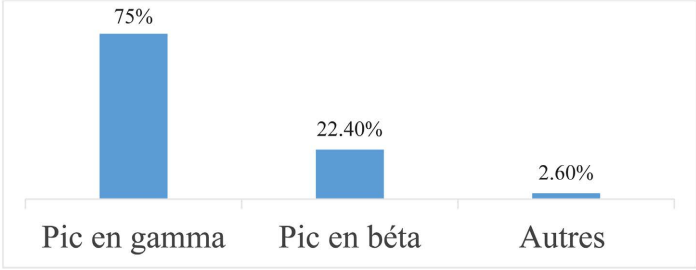

Figure 3. Distribution of patients by migration area from peak to SPEP.

3.3. Monoclonal Ig profile at immunofixation

The IF result was only available in 27 patients (35.52%), in whom the objective Ig was complete.

The isotypic distribution of MM patients according to the type of monoclonal Ig heavy chain revealed a clear predominance of the IgG isotype, which accounted for the majority of cases (92.6%), followed by the IgA isotype (7.40%).

IgD and IgE isotypes were not found in our series.

For light chains, kappa chains were more common (77.8%) than lambda chains (22.2%).

In our series, kappa light chains seemed to be in the majority, and particularly characterized IgG (77.8%) and lambda light chains predominated in the IgG (14.8%) and IgA (7.4%) isotypes (Figure 4).

4. Discussion

Analysis of our results revealed a slight female predominance with a sex ratio of 0.9. This is consistent with the study carried out by Niang E. [6] who had objectified a sex ratio of 0.8 in his study population. Most studies have shown that MM was more common in men than in women with a sex ratio M/F greater than 1, generally close to 1.5, as reported by Bouatay *et al.* [7] where a male predominance with a sex ratio of 1.7 was observed. Similar results were found in the study by

Kyle *et al*. [8] in the United States and that of Ndiaye *et al*. [9] in Senegal.

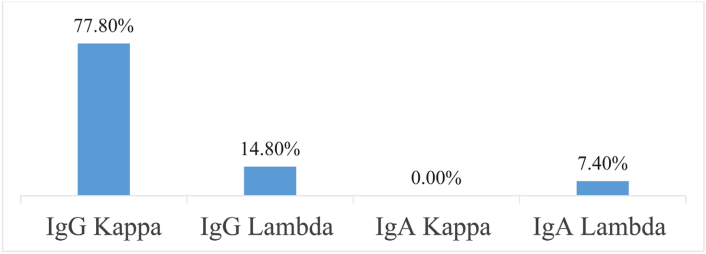

Figure 4. Isotypic distribution of patients with MM.

This discrepancy can simply be explained by the small size of our study sample.

As far as the age of patients at diagnosis is concerned, the data obtained for our population are entirely consistent with those in the literature. Indeed, the average age of our patients was 58 ± 10.24 years and that MM is observed around sixty years, which is corroborated in African publications such as Fall *et al*. [10] in Senegal (59 years), Koffi *et al*. [11] in Côte d'Ivoire (58 years), El Husseiny *et al*. [12] in Egypt (58.5 years), Bouatay *et al*. [7] in Tunisia (67 years), and El Ghali *et al*. [13] in Morocco (62.5 years), these figures show that the risk of developing this disease increases progressively with age.

In our series, a peak in frequency was observed in the age group of 50 to 59 years (40.80%), then in the age group of 60 to 69 years (27.60%), showing that MM is a pathology of the elderly. The occurrence in adolescents and young adults remains exceptional, according to Manier S *et al*. [14].

We found that the majority of requests received came from patients consulting on an outpatient basis (71.1%). This can be explained by the relatively more affordable price of the analysis compared to private laboratories and the non-urgent nature of the analysis.

Regarding SPEP, the mean protein in our series was 91.2 ± 25.2 g/L, and hyperproteinemia was noted in 27.6% of cases, a rate slightly lower than that of Ndiaye *et al*. [9] and El Ghali *et al*. [13].

The hyperproteinemia found is related to the increase in total circulating protein mass due to monoclonal Ig [9]. Hypoalbuminemia was found in 43.40% of our study population. This is consistent with the results of El Ghali *et al*. [13], who found 50% hypoalbuminemia in his study population.

This is because abnormal plasma cells secrete monoclonal proteins, also known as para-proteins or M-proteins, which can bind to albumin and lead to its premature degradation. This reduces the lifespan of albumin in the blood and leads to a decrease in its concentration. Multiple myeloma can also cause kidney damage, and the kidneys can lose their ability to retain albumin in the blood, causing it to be excreted in the urine. This proteinuria may further contribute to the decrease in albumin levels in the blood [15].

For the monoclonal peak found at the SPEP in all our patients: 75% in the γ-globulin migration zone and 22.4% in the β-globulin migration zone, there is

agreement with Kyle *et al*. [8], Bouatay *et al*. [7], Zabsonré *et al*. [16] and El Ghali *et al*. [13], who had respectively found a monoclonal peak in 82%, 75.9%, 87.2%, 87.5% of patients, this peak being mainly located in the γ-globulin zone.

According to the migration profile at the SPEP, monoclonal Ig migrates mainly in the γ-globulin zone. However, not all IgA migrated to the γ zone, as IgA also migrated to β2-globulins [7].

The IF results showed a predominance of the IgG isotype (92.59%), followed by the IgA isotype (7.40%). Our data are consistent with several studies, such as those by Bouatay *et al*. [7], Koffi *et al*. [11], El Husseiny *et al*. [12], El Ghali *et al*. [13] and Younes *et al*. [17]. This could be explained by the fact that physiologically, Ig G is more synthesized than Ig A, and constitutes the majority class of serum Ig, with a higher concentration (13.5 g/L) than that of Ig A (3.5 g/L) [18]. No cases of MM at Ig D and Ig E were detected in our series. These data are similar to those of El Ghali *et al*. [13]. On the other hand, Fall S [19], in addition to Ig G, which is the majority compared to Ig A, found Ig D in a patient in their study carried out in Dakar on infections in multiple myeloma in 2024.

Depending on the type of light chain, a predominance of kappa-type chains (77.77%) was found over lambda-type chains (22.22%). This result is comparable to that of Fall *et al*. [10] (65% kappa and 35% lambda), Koffi *et al*. [11] (75% kappa and 25% lambda), and El Husseiny *et al*. [12] (70% kappa and 30% lambda).

Physiologically, the kappa light chains are synthesized first. Indeed, the rearrangement of the kappa locus precedes that of the lambda locus and, if it is productive, the expression of lambda genes is then inhibited (isotypic exclusion phenomenon) [20]. Thus, the production of kappa light chains is twice as large as that of lambda chains [8], which could explain its higher percentage (two-thirds of light chains are kappa and one-third are lambda).

5. Conclusions

Electrophoresis and immunofixation of serum proteins remain the reference techniques for the research and characterization of monoclonal Ig in multiple myeloma.

Our study allowed us to confirm their undeniable place in the diagnosis and monitoring of this disease, its high prevalence in the elderly, and the predominance of the IgG isotype and the kappa light chain.

A larger-scale prospective Multicenter clinical-biological study would be desirable, in order to monitor in real time the progression of MM in the Senegalese context.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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