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Discussion on the Clinical Diagnostic Value of Serum Immunofixation Electrophoresis, Protein Electrophoresis, Immunoglobulin and Light Chain Quantification in Multiple Myeloma

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Abstract: *Objective:* To explore the value of serum, immunofixation electrophoresis, immunoglobulin and light chain detection in the diagnosis of multiple myeloma (MM). *Methods:* The study started and ended in January 2025 and January 2026 respectively. 100 MM patients admitted to our hospital during this period were included in the analysis. All enrolled patients underwent protein electrophoresis, immunofixation electrophoresis, immunoglobulin and light chain detection, and the test results were statistically collected. *Results:* During immunofixation electrophoresis detection, 81 (81.00%) of the 100 MM patients had significantly concentrated monoclonal bands, including 21 (25.93%) cases of IgA type, 44 (54.32%) cases of IgG type, and 1 (1.23%) case of IgM type. There were 15 (18.52%) cases of free light chain type; protein electrophoresis test showed that among 100 MM patients, a total of 67 (67.00%) cases had M protein bands, including 19 (28.36%) cases of IgA type, 35 (52.24%) cases of IgG type, and 1 IgM type. (1.49%) cases, 12 (17.91%) cases of free light chain type; among 100 MM patients, a total of 80 (80.00%) cases had abnormal immunoglobulin or light chain content, including 19 (23.75%) cases of IgA type and 44 (55.00%) cases of IgG type. Among them, there were 1 (1.25%) case of IgM type and 16 (20.00%) cases of free light chain type; the detection rate of serum protein electrophoresis was lower than that of immunofixation electrophoresis, immunoglobulin and light chain detection, respectively. The total detection rate of combined detection was higher than that of single detection, and the difference was valuable ($p < 0.05$). *Discussion:* Serum immunofixation electrophoresis has a high diagnostic value in the clinical diagnosis of MM, and the value of joint serum protein electrophoresis, immunofixation electrophoresis, immunoglobulin and light chain detection is even more significant, which can further increase the detection rate and is of great significance to the assessment and diagnosis of the disease.

Keywords: Multiple myeloma; Serum immunofixation electrophoresis; Immunoglobulin; Protein electrophoresis; Light chain quantification; Diagnostic value

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1. Introduction

MM is a malignant and proliferative disease with a high clinical incidence. It is highly insidious in the early stages of the disease and is highly likely to be missed in the early stages. After abnormal proliferation of plasma cells in the bone marrow, the body will abnormally secrete a variety of immunoglobulins. This situation can damage multiple organs and then cause MM, which has a serious impact on the overall health of the body. The factors that cause MM are complex, involving chemicals, radiation, viral infections, etc. Plasma cells in the bone marrow are the main source of tumors and are also the final development of B lymphocytes. The early symptoms of MM are not obvious and have diverse clinical manifestations. As the disease progresses, renal insufficiency, bone pain, anemia, bleeding, infection, etc. may occur as the disease progresses. Therefore, active diagnosis and treatment are of great significance to improving the prognosis of patients [1]. Clinically, MM is mainly treated through immunity and bone marrow suppression. The latter is an emerging treatment measure. The former is mainly used for young patients. Both have certain effects and can inhibit the proliferation of tumor cells and help relieve disease symptoms. However, in order to achieve the best effect, effective measures need to be taken to clearly diagnose the disease [2]. In the past, MM was clinically diagnosed through tissue biopsy and bone marrow smear, but studies have found that the detection rate is low, so a method with high accuracy is sought. Reliable diagnostic protocols are of great importance. Based on the above background, this article takes 100 MM patients as the subject and focuses on analyzing the value of serum immunofixation electrophoresis, protein electrophoresis, immunoglobulin, and light chain quantitative examination. The content is as follows.

2. Materials and methods

2.1. General information

The research time range is from January 2025 to January 2026. The research subjects are 100 MM patients diagnosed and treated in the hospital during this period. Analysis of their clinical data shows that: there are 57 and 43 cases in males and females respectively; body mass index (Body Mass) Index (BMI) range is 21–29 (25.00 ± 1.83) kg/m^2; the age range is 28–80 years old, and the mean is (54.00 ± 4.53) years old.

2.2. Research standards

2.2.1. Inclusion criteria

(1) Patients have complete clinical data;
(2) MM is diagnosed based on clinical symptoms, tissue biopsy, and bone marrow smear;
(3) Diagnosis is based on the “Chinese Guidelines for the Diagnosis and Treatment of Multiple Myeloma”;
(4) The study meets ethical standards;
(5) All enrolled patients signed an informed consent form;
(6) There is no history of chemotherapy in the past 3 months.

2.2.2. Exclusion criteria

(1) Combined with serious organic diseases such as hepatorenal syndrome, liver cirrhosis, congenital heart disease;
(2) Mental disorders;
(3) Patients cooperate with the examination and find it difficult to carry out examinations as required;

(4) Autoimmune diseases.

2.3. Research methods

All enrolled patients underwent the same examination, and were given health guidance before collecting specimens. They were instructed to fast the night before the examination. 4 mL of fasting venous blood was collected early the next morning, and the serum was separated after centrifugation (10 min, 3000 r/min). The specimens were stored in a -20 ℃ environment. Serum protein electrophoresis (15 persons/time) was stained with amino black, and measured with Hydrasys2 fully automatic electrophoresis analyzer and supporting kits from Sebia, France, to determine the location of the M protein. Immunofixation electrophoresis was stained with acid violet, and measured with a fully automatic electrophoresis analyzer (Hydrasys2 type) and supporting kits to determine the immune typing. Immunoglobulin and light chain detection are carried out through a fully automatic biochemical analyzer (COBAS8000 C502; ROCHE) and supporting reagents. The measurement method is immunoturbidimetric method to determine the κ and λ levels.

2.4. Observation indicators

The results of serum immunofixation electrophoresis, protein electrophoresis, immunoglobulin, and light chain quantitative examination were analyzed. The normal reference values for IgA, IgG, IgM, κ, and λ are 1.0–4.2 g/L and 8.6–1 respectively. 7.4 g/L, male: 0.3–2.2 g/L, female: 0.5–2.8 g/L, 1.7–3.7 g/L, 0.9–2.1 g/L. If the test indicators exceed the reference range, it can be considered positive. Taking κ/λ1.35–2.65 as the ratio standard, if the value exceeds the reference value, it is regarded as κ type, and vice versa, it is λ type. If the result of any test is positive, the positive M protein can be determined.

2.5. Statistical processing

The data involved in the study were all processed by SPSS23.0 software. The counting data (treatment compliance, adverse reactions) were expressed as "[n/(%)]" and the "χ^2" test was used. The measurement data (blood sugar level, pancreatic islet function) were expressed as "$\bar{x} \pm s$" and the "*t*" test was used. $p < 0.05$ confirmed the existence of differences.

3. Results

3.1. Immunofixation electrophoresis detection and analysis

Among 100 MM patients, serum immunofixation electrophoresis showed that 81 (81.00%) cases had significantly concentrated monoclonal bands, and 19 (19.00%) cases were not detected. M protein types and immunotyping are shown in **Table 1**.

Table 1. Serum immunofixation electrophoresis detection analysis (n = 100, %)

Type	n	Type κ	Type λ
IgA	21	13 (61.90)	8 (38.10)
IgG	44	30 (68.18)	14 (31.82)
IgM	1	1 (100.00)	0 (0.00)
Free light chain type	15	9 (60.00)	6 (40.00)
Total	81	53 (65.43)	28 (34.57)

3.2. Protein electrophoresis detection and analysis

Protein electrophoresis showed that among 100 MM patients, M protein bands were present in 67 (67.00%) cases and undetected in 33 (33.00%) cases. The location and type of M protein are shown in **Table 2**.

Table 2. Protein electrophoresis detection analysis (n = 100, %)

Type	n	γ zone	β zone	B-γ zone
IgA	19	3 (15.79)	10 (52.63)	6 (31.58)
IgG	35	23 (65.71)	7 (20.00)	5 (14.29)
IgM	1	1 (100.00)	0 (0.00)	0 (0.00)
Free light chain type	12	8 (66.67)	2 (16.67)	2 (16.67)
Total	67	35 (52.24)	19 (28.36)	13 (19.40)

3.3. Immunoglobulin and light chain detection and analysis

Immunoglobulin and light chain determination showed that 80 (80.00%) patients had abnormalities and 20 (20.00%) had no abnormalities. The M protein type and immune typing are shown in **Table 3**.

Table 3. Immunoglobulin and light chain detection analysis (n = 100, %)

Type	n	Type κ	Type λ
IgA	19	10 (52.63)	9 (47.37)
IgG	44	33 (75.00)	11 (25.00)
IgM	1	1 (100.00)	0 (0.00)
Free light chain type	16	10 (62.50)	6 (37.50)
Total	80	54 (67.50)	26 (32.50)

3.4. Detection and analysis by different methods

Compared with immunofixation electrophoresis, immunoglobulin and light chain detection, the detection rate of serum protein electrophoresis is lower, and the total detection rate of combined detection is higher than that of single detection, and the difference is valuable ($p < 0.05$). See **Table 4**.

Table 4. Detection analysis by different methods (n = 100, %)

Type	Serum protein electrophoresis	Immunofixation electrophoresis	Immunoglobulin and light chain testing	Joint testing
IgA	18 (18.00)	20 (20.00)	21 (21.00)	24 (24.00)
IgG	38 (38.0)	46 (46.00)	42 (42.00)	56 (56.00)
IgM	1 (1.00)	1 (1.00)	1 (1.00)	1 (1.00)
Free light chain type	10 (10.00)	14 (14.00)	16 (16.00)	17 (17.00)
Total	67 (67.00)	81 (81.00)	80 (80.00)	98 (98.00)

4. Discussions

In recent years, the aging of the population in my country has been severe. Epidemiological data show that the incidence of MM in my country has increased. It is a malignant plasma cell disease originating from plasma cells in the bone marrow. The causes of MM are complex. The main reason is the abnormal

proliferation of monoclonal plasma cells. After the body is invaded by abnormal cell molecules, monoclonal immunoglobulins will be produced in the bone marrow and soft tissues, resulting in an abnormal increase in the amount of M protein [3]. Under the influence of abnormal plasma cells, the body's bone marrow damage is more significant, osteolytic lesions are further aggravated, and patients will experience pain, pathological fractures, etc. After tumor cells enter the organs through blood circulation, they can also cause anemia, bone pain, renal insufficiency, bleeding and other serious conditions. Based on the above situation, the clinical manifestations and conditions of MM patients are extremely complex, so there is a high risk of missed diagnosis and misdiagnosis [4]. Research has found that MM is common in middle-aged and elderly people. However, in recent years, affected by changes in people's lifestyles, the incidence of MM has become younger, which has attracted great attention from all walks of life. In the past, bone marrow cytology was mainly used to evaluate the disease progression clinically. However, due to the dilution, fibrosis, and complex morphology of bone marrow, focal lesions are difficult to identify, and its authenticity deserves further investigation. Affected by the continuous development of medical testing technology, the technology for testing MM has been continuously improved, providing an effective basis for early diagnosis of the disease [5].

Among the 100 MM patients enrolled in this study, the detection rate of serum immunofixation electrophoresis was 81.00%, of which IgA type accounted for 25.93%, IgG type accounted for 54.32%, IgM type accounted for 1.23%, and free light chain type accounted for 18.52%. The main reasons for the analysis are: immunofixation electrophoresis is a common technique for diagnosing MM at this stage, and can clarify the type of monoclonal immunoglobulin. Studies have found that patients with IgA type MM have a higher risk of hyperviscosity, which can lead to elevated cholesterol. Patients with the IgG type have a higher risk of infection, while the IgM type is prone to extramedullary infiltration and bone sclerosis, and these patients are younger, while patients with the free light chain type will lose balance in the abnormal immunoglobulin heavy chain ratio and put a heavier burden on renal function [6]. In this study, the protein electrophoresis detection rate was 67.00%, of which IgA type accounted for 28.36%, IgG type accounted for 52.24%, IgM type accounted for 1.49%, and free light chain type accounted for 17.91%. The analysis found that serum protein electrophoresis detection is relatively simple, can quickly separate proteins to obtain plasma protein profiles, and can effectively screen and determine abnormal proteins in serum. Serum protein electrophoresis diagnosis has many advantages, such as high resolution, accurate results, and good repeatability. The relevant values in the spectrum can be observed from multiple angles, which can accurately reflect the quality changes and separation conditions, and can provide reliable basis for MM diagnosis [7]. In this study, the detection rate of immunoglobulin or light chain detection was 80.00%, of which IgA type accounted for 23.75%, IgG type accounted for 55.00%, IgM type accounted for 1.25%, and free light chain type accounted for 20.00%. Comprehensive analysis shows that immunoglobulin light chain detection is a quantitative detection scheme for immune proteins. This technology is equivalent to the results of serum immunofixation electrophoresis and has high sensitivity for the diagnosis of MM. However, in the actual detection process, due to the varying degrees of immune dysfunction in MM patients, one or more globulins will increase during quantitative immunoglobulin detection, so the diagnostic accuracy will be affected [8]. In this study, the detection rate of serum protein electrophoresis was lower than that of immunofixation electrophoresis, immunoglobulin and light chain detection respectively. The total detection rate of combined detection was higher than that of single detection, and the difference was valuable ($p < 0.05$). Serum protein

electrophoresis detection uses the difference in migration rate of proteins in an electric field to classify serum proteins. It can be used as a preliminary screening program for MM and can quickly detect abnormal M protein narrow bands in the lambda region or other regions. However, serum protein electrophoresis testing can only perform qualitative screening, has low sensitivity, and cannot perform typing. The test results are easily affected by elevated polyclonal globulin. Serum immunofixation electrophoresis is based on protein electrophoresis and can perform immunoprecipitation and typing of electrophoresis bands. It is a reliable standard for confirming M protein and accurate typing. However, this technology has a small resolution for low-level tiny residues and is more dependent on manual interpretation [9]. Immunoglobulin quantification is detected by immunoturbidimetry, which can quantify M protein load and determine the degree of immunoglobulin inhibition, and can evaluate the degree of damage to immune function. Serum free light chains have high sensitivity for untyped MM patients, can accurately determine the clonal proliferation of plasma cells, and can provide early warning of MM progression [10]. Based on the above background, joint diagnosis can comprehensively improve diagnostic accuracy and provide reliable basis for disease evaluation and treatment.

5. Conclusion

In summary, serum immunofixation electrophoresis has a high diagnostic value in the clinical diagnosis of MM, and the value is even more significant by combining serum protein electrophoresis, immunofixation electrophoresis, immunoglobulin and light chain detection, which can further increase the detection rate and is of great significance to the evaluation and diagnosis of the disease.

Disclosure statement

The author declares no conflict of interest.

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