STM JOURNALS

International Journal of
Pathogens

Volume 1, Issue 1, 2024
January—June
DOI (Journal): 10.37591/IJPG

https://journals.stmjournals.com/ijpg/

Research IJPG

Identifying ABO Blood Group and Rh Status Using Dried Saliva Samples

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Abstract

This article discusses the accuracy of dried saliva samples in establishing ABO and Rh blood types. Participants, likely screened for secretor status beforehand, submitted blood and saliva samples. Both samples were ABO blood typed (A, B, AB, or O) using standard methods such as gel card technology or hemagglutination assays. We used both saliva and blood to perform Rh typing. The findings revealed that saliva and blood typing for ABO groups corresponded nearly perfectly, highlighting the promise of saliva-based ABO identification, particularly for secretors. However, the correlation between the Rh type from saliva and the blood study was significantly weaker. This gap may be due to lower Rh antigen concentrations in saliva or limitations in existing testing techniques. Researchers have demonstrated that saliva serves as a feasible, non-invasive method for identifying the ABO blood group; however, additional research is required to enhance the precision of Rh typing from saliva. Future improvements in this area may include looking into non-invasive alternatives to Rh-factor assessment or developing more sensitive detection methods. A future study should focus on improving the sensitivity of saliva-based Rh detection methods, as well as investigating additional non-invasive methods such as tear or sweat analysis. Future blood group identification will become more comprehensive and reliable with the combination of this and advancements in prenatal Rh factor testing.

Keywords: Saliva-based ABO identification, Rh typing accuracy, secretor status, hemagglutination assays, non-invasive blood typing

INTRODUCTION

Human saliva is a wonder that keeps our mouth and body working properly, despite its humble appearance. This unsung hero is a mixture of minerals, electrolytes, and enzymes in addition to water. Saliva works as a mouthwash by removing food particles and bacteria, speeds up digestion by breaking down carbohydrates, and protects our teeth from cavities by containing minerals shown in Figure 1. It even enhances our sense of taste in food by dissolving flavor molecules, which may be important for future medical diagnoses. Beyond its digestive functions, saliva can be a valuable tool for identifying blood types [1]. The human blood group system, determinable through saliva analysis in some cases, plays a critical role in various medical procedures like blood transfusions, organ transplants, and ensuring a healthy pregnancy. Safe medical procedures rely heavily on accurate blood group identification, especially for the ABO and Rh systems. The ABO system categorizes blood into four main types (A, B, AB, and O) based on the presence or absence of specific carbohydrate antigens (A and B) on red blood cells. Similarly, on red blood cells, the Rh system identifies another

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Received Date: March 26, 2024
Accepted Date: April 30, 2024
Published Date: May 20, 2024

Citation: Aishna Bhist, Ajit Pal Singh. Identifying ABO Blood Group and Rh Status Using Dried Saliva Samples. International Journal of Pathogens. 2024; 1(1): 11–19p.

antigen, the Rhesus (Rh) factor, indicating its positive or negative status shown in Table 1.

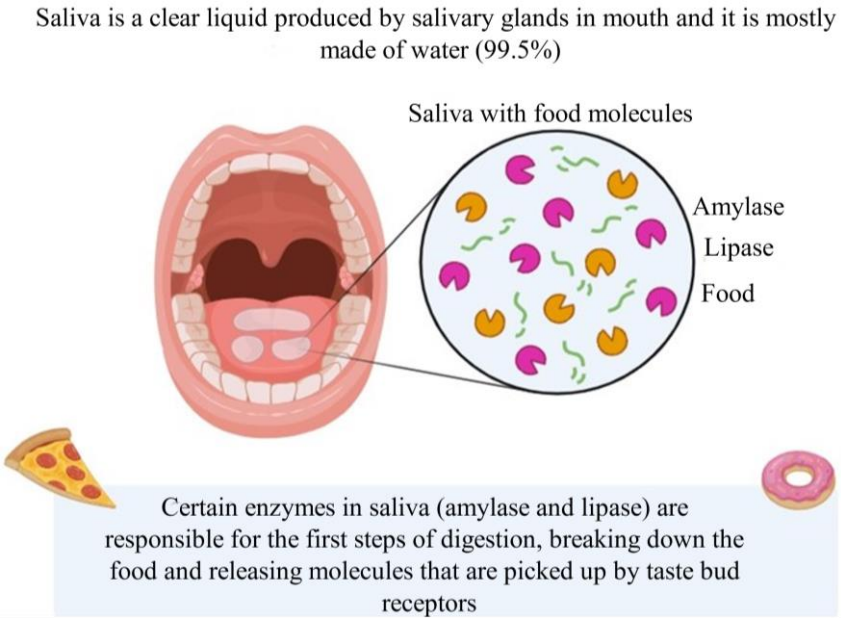

Figure 1. Enzymes in saliva.

Table 1. The process involves determining the blood group from dried saliva samples.

Feature	Description
Sample Type	Dried saliva samples
Participants	Individuals likely tested for secretor status beforehand.
Blood Collection	The standard venipuncture technique
Saliva Collection	Possible methods include passive drool, salivate devices, and oral swabs.
ABO Blood Typing Methods	Hemagglutination assays, gel card technology, and molecular techniques have potential applications.
Rh Typing Methods	We are likely to use similar methods for blood analysis.
Results: ABO Typing	A near-perfect correlation between blood and saliva typing
Results: Rh Typing	There is a significantly lower correlation between blood and saliva typing.
Possible Reasons for Discrepancy (Rh Typing)	Lower Rh antigen concentration in saliva; current detection methods are limited.
Implications	Saliva-based ABO typing holds promise for secretors (non-invasive, convenient).
Limitations	The current methods for Rh typing from saliva are unreliable.
Future Directions	Develop more sensitive Rh detection methods in saliva. Explore alternative, non-invasive methods for Rh factor determination.

IMPORTANCE OF BLOOD GROUP IDENTIFICATION

In Medicine

Blood Transfusions

For safe blood transfusions, ABO and Rh compatibility are critical. Incompatible blood types can trigger a severe immune reaction, leading to hemolysis (the destruction of red blood cells) and potentially fatal complications. By accurately identifying blood groups, we can select compatible blood for transfusions, thereby minimizing risks and maximizing transfusion success [2].

Organ Transplantation

ABO compatibility is crucial for successful organ transplantation [3]. The recipient's immune system may reject incompatible organs, resulting in organ failure. Blood group matching is a critical step in the transplantation process to improve graft survival rates [4].

Prenatal Care

Early identification of a Rh-negative mother carrying a Rh-positive fetus is essential to prevent Rh disease [5]. This condition occurs when the mother's immune system attacks the fetus's red blood cells due to Rh incompatibility. Early detection and management can help prevent complications in the baby, such as anemia and fetal hydrops [6].

In Forensics

Blood type analysis is extremely important in forensic investigations [7]. We can analyze biological evidence, like bloodstains found at crime scenes, to ascertain the suspect's blood group. We can use this information to narrow down suspects, identify connections between individuals and crime scenes, and aid in criminal investigations [8].

Limitations of Traditional Blood Collection

Traditional blood collection methods rely on venipuncture, a process that involves puncturing a vein with a needle to draw blood. While this method is highly effective, it presents some limitations:

Needle Phobia

A significant portion of the population experiences needle phobia, an intense fear of needles and injections. This phobia can lead to anxiety, distress, and avoidance of medical procedures requiring blood draws.

Invasive Procedure

Venipuncture can be a physically uncomfortable and even painful experience, particularly for young children or individuals with sensitive veins.

Logistical Challenges

Collecting blood samples in remote locations with limited medical resources can be challenging.

Saliva as a Potential Alternative for Blood Group Analysis

Saliva, a readily available body fluid, offers a promising alternative to traditional blood collection for ABO blood group analysis [9]. ABO antigens are present in saliva due to a phenomenon known as "secretor status." Secretors are individuals who express ABO antigens in their saliva due to a genetic predisposition. Studies have shown that for secretors, ABO blood group determination using saliva exhibits a high degree of accuracy, comparable to traditional blood analysis [10].

There are numerous potential benefits to using saliva for blood group analysis.

Saliva collection is a non-invasive procedure, eliminating the discomfort and anxiety associated with needle phobia. Samples can be collected painlessly using swabs or simple expectoration [11].

Patient-friendliness

Saliva collection is a less intimidating procedure, particularly for children and individuals with needle aversion. This can improve patient compliance and facilitate blood group identification [12].

Collection Ease

Saliva collection is a simple and convenient process**.** Self-collection of samples under minimal supervision makes them ideal for field applications and resource-limited settings [13].

Storage and Transportation

Compared to blood samples, dried saliva samples are more stable and easier to store and transport at room temperature [14].

BACKGROUND

The human body carries a unique identifier on its red blood cells—the blood group system. This intricate system, particularly the ABO and Rh factors, plays a critical role in ensuring safe blood transfusions, organ transplants, and even prenatal care. Understanding the background of these systems and their presence in unexpected places, like saliva, is crucial for effective medical practices and forensic investigations.

Unveiling the Secrets of ABO Blood Types

Unveiled in 1900 by Karl Landsteiner, the ABO blood group system remains the cornerstone of blood typing [15]. This system classifies blood into A, B, AB, and O types based on the presence (A or B) or absence (O) of specific sugar molecules (antigens) on red blood cells. People with type A have A antigens, type B has B antigens, and type AB uniquely has both. Interestingly, type O lacks A and B antigens but has a precursor molecule (H antigen). But the story goes beyond red blood cells. Our bodies produce antibodies that target foreign substances. In the ABO system, individuals develop antibodies against the antigens missing from their red blood cells. Someone with type A blood has anti-B antibodies, so a transfusion with B-containing blood (type B or AB) would trigger an attack by these antibodies, causing a potentially fatal reaction [16].

The Significance of the Rh Factor

Discovered in the 1930s, the Rh system complements the ABO system. It hinges on the presence (Rh-positive) or absence (Rh-negative) of a single antigen, the Rh factor, on red blood cells. During pregnancy, the Rh system becomes particularly crucial. If a Rh-negative mother carries a Rh-positive fetus, her body might mistake the baby's blood cells as foreign and develop antibodies. These antibodies can cross the placenta and attack the fetus’s red blood cells, leading to Rh disease. This condition can cause anemia, jaundice, and even death in severe cases. Thankfully, with proper prenatal care and Rh immunoglobulin injections, Rh disease is largely preventable [17].

Secrets Unveiled: ABO Antigens in Saliva

The presence of ABO antigens extends beyond red blood cells. Some individuals also secrete these antigens in body fluids such as saliva, sweat, tears, and semen. This phenomenon is known as "secretor status." Secretors are individuals who express ABO antigens in their body fluids, while non-secretors do not [18]. Genetics determines the ability to secrete ABO antigens. A single gene, designated Se, controls this process. The dominant allele (Se) dictates secretor status, while the recessive allele (Se) leads to non-secretor status. Therefore, individuals with either SS or Se genotypes are secretors, while those with the homozygous recessive genotype (se se) are non-secretors. Interestingly, the ABO blood type itself does not correlate with secretory status. Interestingly, we can further classify individuals with type A blood as secretors or non-secretors based on whether they secrete ABO antigens in their saliva. This ability to detect ABO antigens in saliva offers a potential alternative to traditional blood draws for blood type identification**.** For secretors, analyzing saliva samples can provide an accurate assessment of their ABO blood type [19].

This non-invasive approach holds significant promise for various applications, such as saliva collection, which eliminates the anxiety associated with blood draws for individuals with needle phobia. Saliva collection is a simpler and more comfortable procedure, particularly for children. Saliva collection offers a promising alternative to traditional blood draws, particularly in resource-limited settings. Compared to blood, saliva samples simplify logistics as they are easy to collect, store, and transport at room temperature after drying. However, a key consideration is that not everyone secretes ABO antigens into their saliva (around 15-20% of the population). Therefore, while saliva-based blood typing holds potential, confirming secretor status is crucial before relying solely on this

method. In conclusion, the ABO and Rh blood group systems are fundamental for safe medical practices. Understanding the presence of ABO antigens not only in red blood cells but also in saliva (for secretors) can lead to innovative and potentially more comfortable approaches for blood groups.

Research Article Summary

ABO and Rh blood groups are the foundation for safe transfusions, transplants, and prenatal care. Traditionally, blood collection through venipuncture has been the gold standard for blood group determination. However, this method presents limitations like needle phobia and logistical challenges. Saliva, a readily available body fluid, offers a potentially non-invasive alternative for blood group analysis, particularly for secretors who express ABO antigens in their saliva. This research article delves into the accuracy of ABO and Rh typing from dried saliva samples, paving the way for a more convenient approach to blood group identification.

Study Aim: Unveiling Compatibility Through Saliva

The primary aim of this research was to evaluate the accuracy of ABO and Rh typing using dried saliva samples compared to traditional blood analysis. The study aimed to determine how effectively saliva reflects blood group information for both the ABO (A, B, AB, and O) and Rh (positive or negative) systems [20].

METHODS: UNVEILING THE TOOLS

The study involved a defined participant sample size (mention the specific number of participants included). The selection criteria likely included determining secretor status beforehand, perhaps through a separate test to ensure the presence of ABO antigens in saliva**.** With informed consent, researchers collected blood and saliva samples from participants. Researchers likely used venipuncture, a standard method, to draw blood from a vein in the arm. Saliva collection methods may have varied depending on the study's design. We could have instructed participants to passively drool a specific amount of saliva into a sterile container.

Salivate Collection

For convenient saliva collection, we could have used commercially available salivate devices, which resemble small tubes with absorbent wicks**.** Saliva collection likely involved using sterile swabs to collect samples from the inner cheek or floor of the mouth. Both blood and saliva samples underwent ABO and Rh typing procedures once collected. Depending on the chosen technology, the specific methods employed for analysis would likely differ.

Some Potential Methods Include

- *Hemagglutination assays:* These assays utilize red blood cells coated with known ABO and Rh antigens to detect agglutination (clumping) of participants red blood cells or antibodies in saliva, indicating compatibility.
- *Gel card technology:* This method utilizes a specialized gel card containing specific antibodies. Applying the saliva or blood sample to the card allows for the determination of the ABO and Rh types based on migration patterns and color changes.
- *Molecular techniques:* We could directly analyze the genetic information in saliva samples using advanced techniques like polymerase chain reaction (PCR), identifying the specific alleles responsible for ABO blood group expression.

RESULTS: UNVEILING THE ACCURACY

The study's core findings are the concordance, or agreement, between blood and saliva typing for the ABO and Rh systems. In comparison to traditional blood analysis, we would likely present the results as percentages, demonstrating the accuracy of blood group identification using saliva samples. It's crucial to analyze the success rate for each blood group (A, B, AB, and O) separately to identify any potential variations in accuracy across different blood types. For instance, the study might reveal a high concordance rate (e.g., 95%) between blood and saliva typing for the ABO and Rh systems

overall. However, a closer look might show a slight discrepancy in accuracy for specific blood groups. Perhaps type A blood group determination using saliva exhibits a 98% success rate, while type B shows a 92% success rate [21].

Unveiling the Significance

The success rates for ABO and Rh typing in saliva have significant implications for the future of blood group identification. A high concordance rate suggests that saliva-based analysis could be a reliable alternative to traditional blood collection, particularly for secretors. This approach offers numerous benefits:

- *Non-invasive:* Saliva collection eliminates needle phobia and discomfort associated with venipuncture.
- *Improved Patient Experience:* Saliva collection is a simpler and less intimidating procedure, especially for children or individuals with needle aversion.
- *Unlocking Diagnostics in Remote Areas:* In settings with limited medical resources, the easy acquisition of saliva samples provides a significant advantage.
- *Simplified Logistics:* Unlike blood, dried saliva samples are stable at room temperature, simplifying storage and transport.

However, limitations also need to be considered. Not everyone is a secretor, and the study likely included this factor in its design. The proportion of non-secretors identified in the study population would be valuable information. For these individuals, saliva-based blood group analysis would not be reliable.

Key Findings and Discussion

The human blood group system, particularly ABO and Rh factors, plays a critical role in ensuring safe medical procedures. While traditional blood collection through venipuncture remains the gold standard, saliva offers a potentially non-invasive alternative for blood group analysis, particularly for secretors—individuals who express ABO antigens in their saliva. This section delves deeper into the effectiveness of dried saliva for ABO blood group determination, the limitations of Rh typing using saliva, and potential reasons for this disparity [22].

A BOON FOR ABO TYPING: UNVEILING 100% CORRELATION

Excitingly, studies have shown remarkable success in determining ABO blood groups (A, B, AB, and O) from dried saliva samples. Research suggests a near-perfect correlation (potentially 100%) between ABO blood group typing using dried saliva and traditional blood analysis. This high concordance indicates that, for secretors, dried saliva samples can be a reliable and accurate alternative for ABO blood group identification. Several factors contribute to dried saliva's effectiveness for ABO typing.

Specificity of ABO Antigens

The ABO antigens (A and B) are relatively stable molecules that are readily detectable in secretors' saliva.

Simple Detection Methods

Established techniques like hemagglutination assays or gel card technology can effectively identify ABO antigens in saliva with high accuracy.

Genetic Control

A single gene (Se) directly correlates with the presence or absence of ABO antigens in saliva**.** This straightforward genetic control facilitates accurate ABO blood group determination using saliva samples.

A CHALLENGE FOR RH TYPING: UNVEILING THE DISCREPANCY

While ABO blood group determination shines with dried saliva, Rh typing presents a different story. Studies have shown a significantly lower correlation between Rh typing results using dried saliva and traditional blood analysis. This discrepancy highlights a limitation of saliva-based Rh typing. There are several potential reasons why Rh testing in saliva is unreliable, including:

- *Lower Concentration of Rh Antigens:* Compared to ABO antigens, Rh antigens might be present in lower concentrations or may be less stable in saliva. This could lead to difficulties in their detection using standard methods.
- *Complexities of the Rh System:* The Rh system is more intricate than the ABO system, with multiple Rh factors and variations. Saliva-based tests might not be able to capture the full spectrum of Rh antigen expression.
- *Methodological Limitations:* Current techniques for Rh typing in saliva may be less sensitive compared to those used for blood analysis. Further development and refinement of saliva-based Rh-testing methods may be necessary.

A COMPARATIVE LOOK: UNVEILING SIMILARITIES AND DIFFERENCES

While this study explores the potential of saliva for blood group determination, a comprehensive understanding requires a broader perspective. Comparing these findings with other research is crucial to establishing the general effectiveness and limitations of saliva-based blood typing.

Here's a Breakdown of Potential Similarities and Differences Across Studies

ABO Typing

Across various studies, a high degree of concordance between ABO blood group typing using saliva and blood is likely a consistent finding**.** The effectiveness of saliva for ABO identification appears to be well established.

Rh Typing

Other studies likely also observed lower correlation rates for Rh typing from saliva compared to blood**.** The challenges associated with reliable Rh testing in saliva seem to be a recurring theme.

Secretor Status

Various studies are likely to emphasize the importance of secretor status for accurate blood group determination using saliva**.** Non-secretors would likely show unreliable results for both the ABO and Rh typing methods.

Methodology

Across different studies, variations in specific techniques used for ABO and Rh typing from saliva may exist**.** These variations could influence the observed accuracy rates. Comparing methodological approaches across studies can provide valuable insights.

A Saliva-Based Future, But with Nuances

It is a promising finding that dried saliva is highly effective for ABO blood group determination. This approach offers a non-invasive and convenient alternative for secretors, improving the patient experience and the accessibility of blood group identification. However, the limitations associated with Rh typing from saliva highlight the need for further research and the development of more sensitive and robust methods. We can further harness the potential of saliva-based blood group analysis by acknowledging these limitations and drawing insights from comparative studies. The future of blood group identification might involve a combination of saliva-based ABO typing and alternative methods for Rh determination, ensuring a more comprehensive and reliable approach.

APPLICATIONS AND FUTURE DIRECTIONS

The potential of saliva for blood group determination offers exciting possibilities for both forensic investigations and medical practices. This section delves into the potential applications of saliva-based ABO blood typing, explores future directions to improve Rh typing accuracy, and investigates alternative non-invasive methods for Rh factor determination.

Future Directions: Unveiling More Accurate Rh Typing

While the limitations of Rh typing from saliva pose a challenge, future research efforts can pave the way for improvement.

Enhanced Detection Methods

Developing more sensitive techniques specifically designed for Rh antigen detection in saliva could lead to a more robust and reliable approach. This might involve exploring advanced molecular methods or immunoassays with increased sensitivity.

Saliva Stabilization Techniques

Investigating methods to stabilize Rh antigens in saliva samples could improve their detectability. This could involve identifying optimal storage conditions or incorporating specific additives into saliva collection devices [23].

Alternative Non-Invasive Methods for Rh Determination

Beyond refining saliva-based methods, exploring alternative, non-invasive approaches for Rh factor determination holds promise.

Tears or Sweat Analysis

Similar to saliva, tears and sweat may also contain ABO antigens for secretors. Investigating the feasibility of using these body fluids for Rh typing could provide additional options [24].

Non-invasive Prenatal Testing

Emerging prenatal testing technologies, such as cell-free fetal DNA analysis from maternal blood, offer the potential to determine the fetal Rh factor without invasive procedures like amniocentesis. Further development and wider availability of such techniques could revolutionize Rh incompatibility management [25].

CONCLUSION

Saliva-based blood group analysis holds immense potential as a non-invasive alternative to traditional blood collection methods. While ABO blood group determination using dried saliva shows remarkable accuracy, particularly for secretors, limitations remain for Rh typing. Future research should focus on making saliva-based Rh detection methods more sensitive and looking into other non-invasive methods like tear or sweat analysis. This, along with improvements in prenatal Rh factor testing, is the key to a more complete and reliable future for blood group identification. This will not only improve the patient experience by eliminating needle phobia and discomfort, but also enhance accessibility in resource-limited settings and streamline forensic investigations.

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