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Informed consent has been obtained from the patient(s).

Rare Donor Programs

Case Report: Bombay Blood Group

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Background

The Oh blood group was discovered in 1952 in Bombay (now Mumbai, India), which is why it is also known as the Bombay blood group or the Bombay phenotype [1]. It is a very rare variant of the ABO system, with an estimated prevalence of 1 in 10,000 in India and 1 in 1,000,000 in Europe. Globally, approximately 20,000 to 30,000 individuals are affected [2]. In most countries, a blood group is classified as “rare” when it occurs at a frequency of less than 1 in 1,000 [3].

In individuals with the Bombay blood group (Oh), a genetic defect on chromosome 19 prevents the formation of the enzyme fucosyltransferase, thereby inhibiting the synthesis of antigen H – the foundational component of the ABO blood groups (see Figure 1). This genetic defect can either be inherited or arise from a spontaneous mutation. People with this blood group produce antibodies not only against antigens A and B (similar to those with blood group O), but also against antigen H, which is present on the surface of all erythrocytes in the ABO system. As a result, they can only receive blood transfusions from individuals with the Bombay blood group (Oh). A transfusion with an incompatible blood group – including O-negative blood – can lead to severe acute transfusion reactions [4,5]. Another notable characteristic of the Bombay blood group (Oh) is that, similar to blood group O, it is associated with a reduced concentration of von Willebrand factor (vWF) in plasma, which leads to a slightly increased risk of bleeding [6,7].

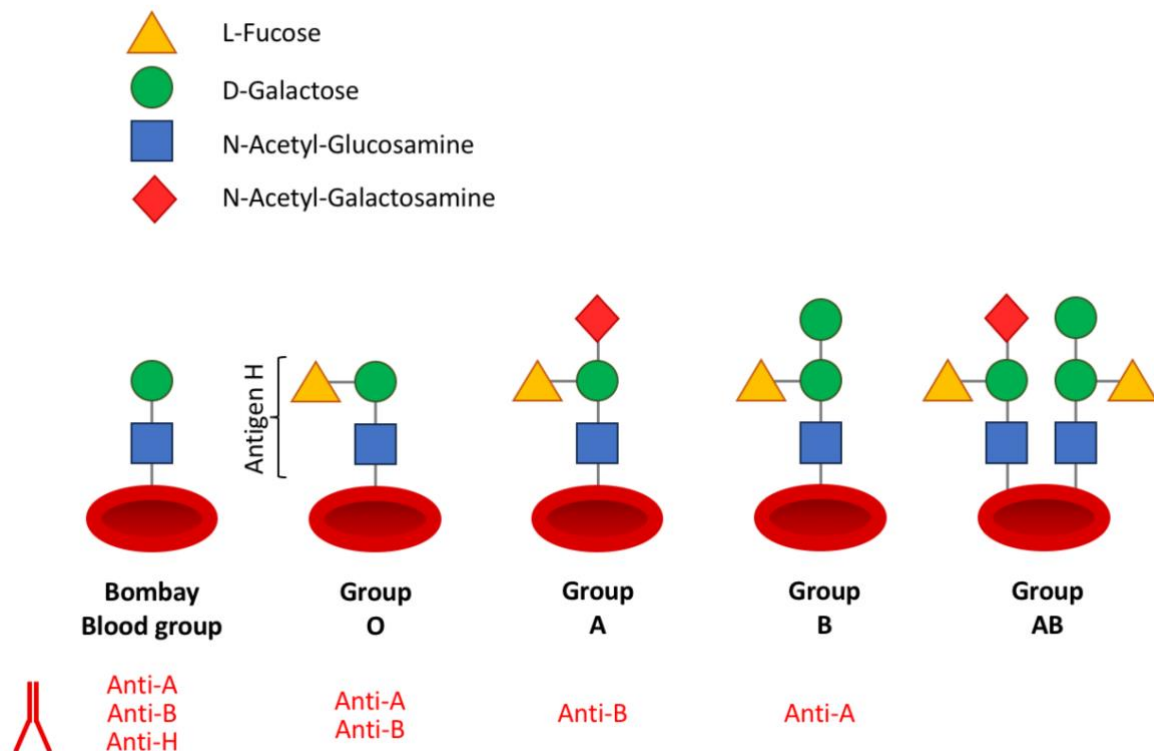


Figure 1: Overview of the blood groups in the ABO system, including the Bombay blood group and their respective antibodies. (Source: Own illustration).

Case Report

A 40-year-old primigravida presented to the anesthesia clinic at 39 weeks of pregnancy (38+0) following a referral from her gynecologist. Due to concerns about potential birth complications, a primary cesarean section was planned. Her medical history included several risk factors, such as advanced maternal age, obesity, and insulin-dependent gestational diabetes, as well as the recently diagnosed Bombay blood group, which was first identified during her pregnancy check-ups. As no other carriers of this extremely rare blood group were known in her family, it was presumed to be a spontaneous mutation. The patient had no history of prior surgeries, and her coagulation profile was unremarkable.

Before the referral to the anesthesia clinic, a hematological consultation was conducted after the discovery of the rare blood group. As part of Patient Blood Management (PBM), the patient received two doses of Ferinject and oral iron supplementation.

In summary, the patient had an otherwise uncomplicated pregnancy with no severe comorbidities. However, challenges included her risk factors for postpartum hemorrhage (PPH; see Table 1) and her status as a carrier of the rare Bombay blood group, which poses an absolute incompatibility with all other ABO blood groups. Additionally, due to the rarity of the Bombay blood group, compatible erythrocyte concentrates are cryopreserved in select centers and are not immediately available. The proximity to her delivery date added an element of urgency, requiring meticulous planning and coordination with both national and international blood donation services.

Excursus: Postpartum Hemorrhage (PPH)

Blood loss during an uncomplicated delivery is typically around 300 ml. However, in complicated cases, this can increase to life-threatening amounts. Current international guidelines define postpartum hemorrhage (PPH) as blood loss exceeding 500 ml, with severe PPH classified as blood loss over 1,000 ml [8]. In German-speaking countries, an additional distinction is made based on the mode of delivery, with threshold values set at 500 ml for vaginal births and 1,000 ml for cesarean sections [9]. The incidence of PPH varies in the literature, with reports suggesting it occurs in approximately 3% of all births, and it is associated with high morbidity and mortality. Risk factors for PPH are summarized in Table 1.

Although the most common causes of postpartum hemorrhage – the “4T’s” (Tone, Trauma, Tissue, Thrombin) – can typically be managed with uterotonics and coagulation management via factor substitution, the need for blood transfusion after childbirth is estimated to be around 1-3% worldwide [9,11].

Risk Factors for PPH	
Sociodemographic Risk Factors	Obesity (BMI > 35) Maternal Age (≥ 30)
Obstetric Risk Factors	Placenta previa Premature placental abruption Preeclampsia Multiple pregnancy History of postpartum hemorrhage (PPH) Fetal macrosomia HELLP syndrome

	Hydramnios (Prolonged) oxytocin augmentation Induction of labor Prolonged labor Fibroids Uterine malformations High multiparity
Operative Risk Factors	Non-elective cesarean section Elective cesarean section Operative vaginal delivery Episiotomy Perineal tear
Other Risk Factors	Antepartum hemorrhage Von Willebrand syndrome (especially type 2 and 3) Anemia (< 9 g/dl) Hypofibrinogenemia, carrier hemophilia, platelet function disorders, hemoglobinopathies, factor deficiencies (rare bleeding disorders, rare blood types, etc.)

Table 1: Risk Factors for Postpartum Hemorrhage (PPH) [Source: Peripartal bleeding, diagnosis and therapy of DDDG, OEGGGG, SGGG] [11,12].

Searching for Suitable Donors in Switzerland

To organize compatible erythrocyte concentrates in the event of significant peripartum hemorrhage, our hematology department contacted the Swiss Red Cross Blood Donation Service in Zurich. The “Rare Donor File” is a national database, maintained through the cooperation of all regional blood donation services in Switzerland, and is regularly updated. Its purpose is to ensure the supply of blood for patients with rare blood types. Since 2023, the Swiss Red Cross Blood Donation Service in Zurich has been responsible for managing and maintaining this database [13].

The Swiss Red Cross Blood Donation Service was able to identify a donor with the Bombay blood group, who fortunately agreed to donate an erythrocyte concentrate in a timely manner. As a result, a freshly donated blood unit with a shelf life of 42 days was secured for the cesarean section.

Organization of Cryopreserved Erythrocyte Concentrates

In Europe, several blood banks maintain a reserve of cryopreserved erythrocyte concentrates. The preservation methods differ across centers, which significantly affects the shelf life of thawed blood products [14]. Notably, the preservation method used by the Paris blood bank offers the advantage of a longer shelf life of 48 hours after thawing. After contacting the Paris blood bank, it was possible to obtain two erythrocyte concentrates with a precisely matching antigen profile.

Cryopreserved erythrocyte concentrates can only be issued on an “all or nothing” basis. Due to the high effort, significant costs, and logistical complexity involved, it is not possible to reintroduce once-supplied blood products back into the cryopreservation inventory [15].

Transport to Switzerland

The cryopreserved erythrocyte concentrates must be thawed slowly over a period of 6 hours in Paris and then undergo a quality check. This process can begin no earlier than 6 a.m. and is typically

completed between 12 p.m. and 2 p.m. The transport of thawed and refrigerated blood products is carried out by a specially certified transport company. According to customs regulations, the border crossing for blood products is only permitted between 8 a.m. and 4 p.m. However, a special permit can be granted for emergency situations, extending the allowed transport window until 9 p.m. Since this import procedure can only be completed on weekdays, the patient's cesarean section was postponed.

After a smooth transport, the two blood products arrived in Zurich, where an additional crossmatch with the patient's blood was performed before they were forwarded to Lucerne. They finally arrived in Lucerne at midnight, making them available for the cesarean section the following day.

Uneventful Cesarean Section

In a subsequent outpatient pre-examination, the placenta had already been assessed sonographically for signs of placenta accreta spectrum (PAS), and no indications of a bleeding-related placentation disorder were found.

Upon admission, hemoglobin was remeasured and found to be 125 g/l. Given the previously noted reduced von Willebrand factor (vWF) in the Bombay blood group, the patient was prescribed prophylactic oral tranexamic acid the night before surgery. With preoperative fibrinogen levels within the normal range (> 3 g/l), prophylactic administration of fibrinogen was omitted. Following the uneventful administration of spinal anesthesia, tranexamic acid was again administered as a short infusion.

The cesarean section was performed without complications, and the child developed well. With a blood loss of 400 ml, both the retransfusion of blood collected with the Cell Saver and the transfusion of the requested blood products were avoided. After cord clamping, 100 µg of Pabal (Carbetocin) was administered for atony prophylaxis, resulting in adequate uterine contraction. As hoped, the procedure was completed without any bleeding complications.

Postnatally, the child developed well. In contrast to the mother, it carried a common blood group, and there were no indications of neonatal hemolytic disease. Postoperative monitoring in the delivery room included intensified postpartum observation to rule out any postpartum hemorrhage. The patient was transferred to the normal ward that same evening and was discharged home with her child on the fourth postoperative day.

Discussion

This case report aims to provide an overview of the necessary steps involved in searching for donors and blood products for rare blood groups, as well as to highlight the challenges in the organization and import process.

The Swiss Red Cross Blood Donation Service in Zurich maintains a regularly updated national database of donors with rare blood types, known as the "Rare Donor File." If a suitable donor cannot be found or if demand exceeds supply, the search is extended to neighboring European countries. On the international level, the World Health Organization (WHO) coordinates the International Rare Donor Panel (IRDP), which includes 27 countries, Switzerland among them [16].

Nearby countries with blood banks that store cryopreserved erythrocyte concentrates include Paris, Vienna, Ulm, Hagen, and Amsterdam. Due to time constraints following thawing, the complexity of the import process as described in our case, and the longer shelf life of blood products stored there, Paris is particularly recommended as a contact point.

Typically, patients become aware of the scarcity of the rare Bombay blood group during their treatment, and, following recovery, they may choose to become donors. After completing treatment and recovery, patients should be offered outreach and informational discussions about voluntary blood donation.

Key Points for Practice

- The Bombay blood group (Oh) is a very rare blood type, with a prevalence of approximately 1 in 1,000,000.
- Transfusion of incompatible blood — including O negative — can lead to severe acute transfusion reactions in carriers of the Bombay blood group (Oh).
- National and international rare donor programs exist to search for rare donors and blood products, with the Swiss Red Cross Blood Donation Service serving as a primary point of contact.
- The import of cryopreserved erythrocyte concentrates from abroad requires careful organizational planning due to limited shelf life after thawing and customs import regulations. This may necessitate rescheduling surgery dates for planned procedures involving potentially significant blood loss. Cryopreserved concentrates are not suitable as an emergency strategy.
- Patients with rare blood groups should be referred early to a central hospital and treated in an interdisciplinary manner (involving obstetrics, anesthesia, hematology). This also includes developing an emergency strategy. Early contact with blood donation services is crucial for patients with rare blood groups.

Statements

Informed Consent Statement

A written informed consent for publication is available.

Conflict of Interest Statement

The authors have declared that they have no potential conflicts of interest.

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