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A single center comparison between three different apheresis systems for autologous and allogeneic stem cell collections

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ABSTRACT

Three different apheresis systems were used in our center for the collection of peripheral blood progenitor cells (PBPCs): COM.TEC (Fresenius Healthcare), COBE Spectra, and Spectra Optia (both from Caridian BCT). We compared 131 autologous and 56 allogeneic apheresis procedures to elucidate feasibility and effectiveness of the different systems. Collection efficiacy varied significantly with lowest results obtained with COBE Spectra. COM.TEC and Spectra Optia produced lower WBC contamination than COBE Spectra, but at the expense of higher product volume and longer apheresis time. High collection efficacy and a low product volume may be favorable characteristics of the Spectra Optia.

1. Introduction

Peripheral blood progenitor cells (PBPCs) are the most common stem cell source for autologous or allogeneic stem cell transplantation in Germany, covering approximately two third of all procedures [1,2]. Apparent advantages of PBPC collection versus collection of bone marrow for adults are higher stem cell doses, a more rapid engraftment and a favorable graft versus tumour effect [3,4]. Advantages for the donor include a less painful collection procedure in an ambulant setting with no exposure to narcotics. Relevant disadvantages for the donor are the side-effects that come with the mobilization CD34+ cells by G-CSF application [2,3]. In our center, three different apheresis systems were used for the collection of PBPC: Fresenius COM.TEC version 04/02 (Fresenius Healthcare, Bad Homburg, Germany), an apheresis system with continuous blood flow, collecting PBPC cyclically at the end of each individually determined separation cycle in a one-stage separation chamber [5]; and COBE Spectra and Spectra Optia (both from Caridian BCT, Garching, Germany). Both Caridian BCT systems provide a continuous blood flow. Whereas the COBE Spectra MNC apheresis system permits manually controlled continuous PBPC harvesting, the Optia provides an automated buffy coat interface control and combines centrifugation with subsequent cellular collection into an elutriation chamber with intermittent PBPC harvesting [6]. We were interested in comparing the feasibility and effectiveness of these systems by comparing collection efficacy, collection rate, throughput, platelet loss, and the composition of the final stem cell product.

Abbreviations: BW, body weight; CE, collection efficacy; CR, collection rate; NHL, Non-Hodgkin lymphoma; G-CSF, Granulocyte-Colony Stimulating Factor; PBPCs, peripheral blood progenitor cells; PLT, Platelet; TPV, Total processed volume; WBC, White Blood Count.

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2. Materials and methods

2.1. Patients

Clinical indication and eligibility for mobilized stem cell apheresis were determined by the treating physicians, as was number of transplants and the CD34+ target dose. For apheresis all adults were referred to the department of transfusion medicine for autologous or allogenic stem cell apheresis after agreement of the patient [7,8].

2.2. Mobilization

In all cancer patients, hematopoiesis was ablated with chemotherapy, consisting of DHAP (Dexamethason 40 mg 1–4 die, AraC 2×1 g/m^2 on day 2, Cisplatin 100 mg/m^2 on day 1) in patients with Non-Hodgkin's lymphoma or AraC 3 g/m^2 on day 1–2, Thiotepa 40 mg/m^2 on day 2 in patients with primary cerebral B-NHL. Patients with multiple myeloma received Cyclophosphamid 2 g/m^2 on day 1–2, and patients with germ cell tumors received PEI (Cisplatin 20 mg/m^2, Etoposid 75 mg/m^2, Ifosfamid 1.2 g/m^2 on day 1–5), TIP (Paclitaxel 175 mg/m^2 day 1, Cisplatin 20 mg/m^2 day 2–6, Ifosfamid 1.2 g/m^2 day 2–6) or TI (Paclitaxel 175 mg/m^2 day 1, Ifosfamid 5 g/m^2 for 24 h day 1). In case of non-mobilization, Etoposid was given in a second cycle (1.5 g/m^2 for 24 h). Subsequently, G-CSF was injected twice a day at 5 μg/kg BW. Healthy matched stem cell donors were stimulated with G-CSF twice daily at 5 μg/kg BW [9]. Collection of PBPC was performed on day 5.

The apheresis target dose for one autologous transplant was 3×10^6 CD34+/kg body weight or more before freezing. In allogeneic setting the apheresis target was 5×10^6 CD34+/kg body weight per transplant.

2.3. Collection of PBPC

Stem cell collection was performed according to the manufacturers' recommendations [6,10]. All patients were collected via a peripheral venous access (usually 16–18 G, allowing for a flow of at least 80 ml/min); a 20 G venous cannula was placed in the opposite arm for return line. In order to avoid severe hypocalcaemia during the procedure, all patients received an intravenous infusion of 10% calcium gluconate at a rate of 6–8 ml/h providing up to 819 mg of calcium per apheresis. Due to this procedure, no side effects in regard to hypocalcemia were seen. Using the COM.TEC or COBE Spectra, the buffy coat interface was controlled by the operator using a Cologram (target value 2–5%). The separation factor remained unchanged during the apheresis procedure using COBE Spectra in all patients regardless of the actual WBC count. With Spectra Optia, collection of the buffy coat from the elutriation chamber was triggered manually when the operator observed a buffy coat overflow earlier than the red blood cell sensor.

2.4. Laboratory methods

Blood count was analyzed before and after apheresis from peripheral blood using a hematology analyzer (Sysmex, Norderstedt, Germany). CD34+ cells were counted in pre- and post-apheresis peripheral blood samples as well as in a product sample by flow cytometry using a commercially available single-platform assay (BD stem cell enumeration kit, BectonDickinson, Heidelberg, Germany) [11,12].

2.5. Calculation of parameters

The CD34+ cell dose per kg body weight was determined. The collection efficacy was calculated as previously suggested [13,14]: CE1% = CD34+/μl product × product volume/((CD34+ pre-apheresis + CD34+ post-apheresis)/2× total processed volume) and CE 2% = CD34+/μl product × product volume/CD34+ pre-apheresis × total processed volume (TPV). The collection rate was calculated as CR (ml/kg) = CD34+/kgBW in product/CD34+ pre-apheresis [15], and the throughput as (CR/min) = CR/procedure time) [13]. Platelet loss during apheresis was calculated as PLT loss% = ((platelet pre-apheresis/μl − platelet post-apheresis/μl)/platelet pre-apheresis/μl) × 100 [16].

2.6. Statistical analysis

Descriptive statistics and comparison between the groups was performed by SPSS applying Mann–Whitney-U test or Kruskal–Wallis test where appropriate; $p < 0.05$ was considered to indicate significance. Descriptive data are given as mean and range.

3. Results

3.1. Donor demographics

In total, 131 autologous and 56 allogeneic apheresis procedures were evaluated between January 2008 and November 2011. The diagnoses in patients scheduled for autologous transplantation were multiple myeloma (two third), Non-Hodgkin's lymphoma (one fifths), and germ cell tumours. Details are given in Tables 1 and 2. Except for donor age, there were no relevant differences between the three apheresis groups.

3.2. Apheresis procedure, flow rates, and apheresis time

All apheresis procedures were tolerated without side effects; even citrate reactions were not observed. Performance details are summarized in Tables 3 and 4. In allogeneic donors, highest flow rates were obtained with COBE Spectra with a medium inlet flow rate of 66 ml/min, whereas COM.TEC and Spectra Optia allowed for medium flow rates of approximately 50 ml/min only ($p < 0.01$). Accordingly, COBE Spectra allowed for the shortest apheresis time of all systems ($p < 0.001$).

A comparable outcome was obtained for autologous procedures, with highest flow rates ($p < 0.05$) and shortest apheresis times ($p < 0.001$) for COBE Spectra. Longest apheresis times were again required when autologous donors were processed with Spectra Optia.

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