augmentation by G-CSF. A total of 2 leukapheresis were performed with CD34+ cell yields of 2.8 x 10^6 and 24.6 x 10^6 each. No complications were encountered during the PBSC harvests. The stem cells were cryopreserved with 10% DMSO and kept in liquid nitrogen.

Following PBSC collection, the patient underwent a laparotomy for resection of the primary thoraco-abdominal neuroblastoma. As the tumour had infiltrated the intercostal and paravertebral muscles, only gross total resection could be achieved. Irradiation was given to the thoracic area with macroscopic residual disease. She was then prepared for her PBSCT with conditioning using carboplatin, teniposide and melphalan. On the day of transplant, her stem cells were thawed and reinfused with no complications. The patient's absolute neutrophil count was >500/µl by Day 13 while her platelet count was >50,000/µl on Day 49. She was discharged well on Day 91 post-transplant and is currently well with no evidence of disease.

Discussion

Stem cell transplantation for the treatment of malignant and non-malignant disorders gained acceptance in the 1970s. Today there is no doubt that stem cell transplantation for acute lymphoblastic leukaemia in 2nd remission, acute myeloid leukaemia and chronic myeloid leukaemia offers better survival rates compared with conventional chemotherapy[21,22,23,24]. Increasing numbers of children with congenital immune deficiences and metabolic disorders are benefiting from transplantation. Although the role of stem cell transplantation in childhood solid tumours is not clearly established, there is an increasing trend towards this modality of treatment particularly for disseminated neuroblastoma, rhabdomyosarcoma and germ cell tumours, together with high-risk brain tumours.

The initial source of stem cells was the bone marrow either autologous (from the patient) or allogeneic (from a healthy donor). Studies showed that progenitor stem cells were also present in peripheral blood and numerous strategies were tested to mobilize and increase the number of these progenitors for collection[25,26,27,28,29]. The combination of chemotherapy- recovery with G-CSF has proven to be one of the most effective mobilization techniques and was employed for both the cases described. The number of stem cells which can be mobilised varies between patients and is low for patients who are heavily pre-treated with multiple courses of chemotherapy. This is reflected in the stem cell yields in Case No. 2.

Successful collection of stem cells from peripheral blood for transplantation is a culmination of various technologies which had matured over the 1980s. These technologies included improved blood cell separators and apheresis procedures, blood cell component isolation and cryopreservation. In addition immunophenotyping techniques using the surface marker CD34 for identification of the stem cell were also developed for rapid and reproducible results. The refinement of these various technologies made available PBSC for haematopoietic rescue after high dose chemotherapy. Moving in tandem, clinicians were formulating more intensive chemotherapeutic regimes in their efforts to improve cure rates for advanced cancers which remained chemosensitive.

In University Hospital, Kuala Lumpur, allogeneic bone marrow transplantation had been performed for paediatric patients since April 1987. It was only in August 1996 that we were able to start cryopreservation initially for placental cord blood samples and later in December 1996 for PBSC. We are still at an early stage of the learning curve. To date we have conducted 34 PBSC collections on 13 children with a median age of 4.5 years (range 5 months - 17 years) and weight of 13.1kg (range 5.7 - 53 kg). The training of apheresis nurses and medical laboratory technologists present another challenge. Immunophenotyping techniques identifying CD34+ cells need standardization. Cell culture to test the viability and proliferative capabilities of stem cells, is routinely performed in established transplant centres and may need to be established here.

We see the potential for PBSC transplantation following high dose chemotherapy for advanced cancers in childhood. Speedier engraftment translates into shortened hospitalisation with decreased transfusion and antibiotic support and would be advantageous in this age of cost consciousness. This has proved true even with the limited number of PBSCTs we have performed. Both our patients engrafted on Day 7 and 13

respectively which compares favourably with the median day of engraftment of Day 20 for our patients with bone marrow transplantation[30]. Collection of PBSC from very small children presents problems with venous access but these are not insurmountable. Use of radial arterial lines[17], silastic central venous catheters[31,32], polyurethrane haemocatheters[18,19], polyurethrane central venous catheters[32] has all been described for paediatric patients with variable success. We find that the polyurethrane haemocatheter allows a good blood flow but requires a general anaesthetic for insertion in the paediatric population. Although infection of the haemocatheters has seldom been reported, we find this an extremely common problem in our hands.

Conclusion

Our limited experience demonstrates the feasibility of PBSC collection for cryopreservation and transplantation after high dose chemotherapy in small paediatric patients and its immediate advantages are already evident. These advantages are particularly critical in Malaysia where transplant resources are limited and waiting lists are long. Indeed PBSCT is expected to supplant BMT both in the autologous and allogeneic setting. Whether this strategy will translate into improved survival and disease free outcome for our patients with advanced cancers awaits larger studies with longer follow up.

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