京都大学若手人材海外派遣事業　スーパージョン万プログラム
研究者派遣プログラム

英文報告書

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1．渡航者　（日本語）			
氏　名	松尾幸憲	採択年度	平成２５年度　第２回
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研究課題名	Vero システムを用いた動体追尾放射線治療		
海外渡航期間	平成 26 年　1 月 20 日〜　平成 27 年　1 月 19 日		
渡航先 （英語表記）	国名：Belgium 大学等研究機関名：University Hospital Brussels (UZ Brussel) 研究室名等：Department of Radiotherapy 受入研究者名：Profs. Mark De Ridder and Dirk Verellen		

2．渡航の報告　（英文）
　渡航先の研究環境、研究者との交流、研究発表の状況等、渡航中の滞在経験について英語（500〜1000語）で記述して下さい。受入研究者と撮影した写真や研究発表で用いた図等について、可能な範囲で別添として提出して下さい。ページ数については増加してもかまいません。

UZ Brussel is a university hospital which belongs to the Vrije Universiteit Brussel (VUB) in Belgium. The VUB can be translated as the Free University of Brussels in English. However, this English translation is confusing because there is another Free University of Brussels. That is the Université libre de Bruxelles (ULB) for French speaking Belgians. To avoid this confusion, the names of VUB and ULB are usually used. At UZ Brussel, I belonged to the Radiotherapy Department. The department consisted of 6 staff physicians, 3 senior residents, 3 residents-in-training, 3 medical physicists and 3 dosimetrists. They had 6 linacs (1 VERO, 1 Novalis, 1 Elekta and 2 Tomotherapy in the main hospital, and 1 Elekta in the satellite hospital). The situation was similar to our radiation oncology department in Kyoto University (8 staff physicians, 5 residents and 4 staff physicists; and 4 linacs). The VERO is a novel radiotherapy system, which allows us to track tumors in real time. Kyoto University is a research site of the VERO in Japan, and the UZB is another developing site in Europe. Kyoto and Brussels are collaborating on the VERO development. This collaboration gave me an opportunity to do research works at UZ Brussel.

I joined the VERO project, especially for a transdisciplinary area between clinics and medical physics. My main research topics were comparison of treatment procedures and errors in dynamic tumor tracking with the VERO system between Japan and Belgium and estimation of optimal PTV margins for individual institutions. Firstly, I started with a kind of mathematical work to establish a method to classify the tracking errors into some components according to their origins. The conventional method of error evaluation in the radiotherapy field had considered only one factor and not exactly partitioned the errors. I applied the variance component analysis to exact computation of the error components. I classified the tracking errors into 4 components: patient, fraction, model and residuals. With

this method, origins for the errors could be precisely evaluated. Then, I found that body habitus (body mass index), use of body fixation device and quality of correlation models mainly contributed to the tracking errors. These preliminary data were presented at the EPI2k14 meeting held in Aarhus, Denmark in early September 2014. After the meeting, my work moved to next stage for the optimal PTV margin. I discussed methods to calculate the margin with medical physicists as well as interpretation of the results with physicians at UZ Brussel. Finally, I completed the work and submitted a paper to the *Radiotherapy and Oncology*, which is one of the top-ranked journals in radiation oncology field in December 2014.

Based on this work, the radiotherapy departments at UZ Brussel and Kyoto University agreed with a future collaboration on researched and development of the VERO system. We have just applied a grant for the collaboration for coming 2 years to the Japan Society for Promotion of Science (JSPS).

Belgium is a multi-lingual country with three official languages of Dutch, French and German. Flanders (north area of Belgium) people speak Dutch, and the Wallonia (south area) speak French. There is a so-called "language war" between the Flanders and Wallonia. As described above, there are two Free Universities in Brussels: VUB and ULB. The two had been originally one university, but divided in 1970. Leuven University also divided into two in 1968. One of my colleagues said that he could not understand why they unite as one country. National election was held in Belgium in May 2014. The N-VA, a party which claimed independence of the Flanders, won the first party in Belgian Federal government. The election result potentially had a risk of split of the country like Scotland from the UK or Catalonia from Spain. However, the country split was avoided with the prime minister selected from the third party, after five months of discussion considering a balance between the two areas. It was interesting for me that Belgium people united with each other over the language barrier for FIFA World Cup in July 2014, where the Belgian team advanced to quarterfinal.

In conclusion, the experiences at UZ Brussel and in Belgium were very valuable for me. I'd like to play a role in bridging the two departments of Brussels and Kyoto. I express my greatest appreciation for warm support from professors Verellen and De Ridder, and the colleagues at UZ Brussel and from professor Hiraoka and my colleagues at Kyoto University; and financial support by Kyoto University through the Jong Mung Program.