REPORT

Robotic Travelling Fellowship 2023

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## Fellowship report

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| **Date of the fellowship:** | **09-27 January 2023** |
| **Visited institutions:** | **University College London Hospital, Princess Grace Hospital & Glasgow Jubilee Hospital** |


*Acknowledgements*

I would like to thank EFORT and Stryker for their generous contributions and support to allow me to undertake this highly competitive travelling fellowship across the UK. Thank you to all the trainers who allowed us to be involved in surgeries and provided thorough explanation of the steps undertaken. My special thanks to Sabrina Marchal for making this a fantastic experience.


This fellowship provided exceptional clinical experiences meet new mentors and develop friendships that will no doubt help me build a great network in the future.

*Fellowship Report*

My interest is specialising in knee arthroplasty, and I had little exposure of robotics during my training and was so this provided a great exposure as I am very interested in the use of robotics in my future practice. This fellowship was planned that it gave me an intensive 3-week insight at the three centres, University Central London Hospital (UCLH), Princess Grace Hospital, London and Golden Jubilee Hospital, Glasgow with the high volume of robotic-assisted arthroplasty.

REPORT

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I first visited UCLH with Professor Haddad and his team, an advocate for robotic arthroplasty. This hospital had the first MAKO in the country and since has the highest usage of robotic-assisted arthroplasty. The productivity in professor's theatres was next to none I have seen, this debunked the myth that robotic-assisted arthroplasty slowed down a regular list.

At Princess Grace Hospital, the variety of surgeries we were exposed showed MAKO robot's versatility. The MAKO was utilised in different approaches of hip, with the use of uncemented and hybrid THR, cemented and cementless TKR, PFJ replacement, medial & lateral partial uniknee replacement and bicompartmental knee replacement. This is also where I was introduced to functional alignment principle.


The MAKO product specialist(s) were extremely helpful and explained the steps from initial scans to how the software assists the surgeon in planning cuts and alignment and its affect on flexion/extension gaps. I was incredibly humbled with team centered approach that was facilitated with the assistance of navigated software system. This allowed the Surgeon, surgical assistants, and team to corroborate and discuss the effects of changing alignment and its affect during the operation rather than at end of the procedure.

Whilst in Golden Jubilee Hospital, one of the highest volume centres of arthroplasty in Europe we saw different types of navigated systems/robotic systems and could clearly see how user-friendly MAKO system was and differences between other systems.

Mr Nick Ohly performed robotic assisted knees and showed his kinematic alignment method and how the plans resulted in accurate reproduction.

I also had the opportunity to join other lists with Mr Chris Gee and Mr Kamaldeep and all had positive reviews of their experience with the system.

Other than clinical and scientific activities, we had several social dinners. At UCLH, the fellows took us out to dinner on many occasions to several fancy establishments, it was great to see the fellows bond over a hearty meal and drinks.

At Glasgow, we were fortunate of to join a preplanned social at Òran Mór bar followed by a lovely meal with all the surgeons, mako product specialists and staff at the renowned Scottish restaurant Stravaigin. It was a delight to see group getting on well. Accommodation and transport was subsidised and was great.

We also got the opportunity to explore the Glasgow city and see how friendly and cosmopolitan it was and appreciated visiting its cultural sites.

The use of the robot complimented surgery, rather than being a hindrance. The MPS and the surgeon will review the plan before the surgery in the Pre-op mode. It will be agreed upon prior to the start of the operation, and then steps planned will be executed smoothly, and minor adjustments would be made. The CT had to be of a particular standard for arthroplasty planning.

In this Pre-op mode for total hip arthroplasty, the hip length, and combined offset discrepancy were reviewed and compared to the opposite hip. Cup planning could be adjusted to desired degrees of inclination and version. This allowed for visualization of different CT views to establish correct placement and also adjust for possible impingement.

The MAKO has ‘Enhanced’ or ‘Express’ femoral workflow options. The enhanced option allowed for accurate neck resection, broach and stem tracking, combined anteversion, along with hip length and combined offset.

During this period, I had the opportunity to see several surgeons, and it was reassuring to see that in all institutions, no complications or issues were noted. More impressive was that robotic-assisted surgery also had a seamless workflow execution.

The approaches to the surgery did not change significantly. Some surgeons incorporated the arrays into their skin incisions, while others made a separate incision. Once applied, the arrays did not seem to loosen or dislodge, and the infrared camera was able to easily identify them.
The Knee arthroplasty setup had the MAKO Robot on the operator's side, while the Infrared camera and the screen were set up on the other side for the surgeon to review. The setup for Hip arthroplasty would be that the robot will be on the opposite side and comes across when cuts or reaming is required.

If the patient was positioned supine, the arrays for the acetabulum could be put on the contralateral iliac crest. The important practical point noted was that bone pins had to be secure, and the fixation of arrays to clamps to pins were tightened. The RIO Registration process registers the end of the Robotic Arm to the Robotic Arm Base Array. This step confirms the accuracy of the Robotic Arm and the location of the cutting tool tip.

Bone registration has three specific steps: Patient Landmarks, Bone Checkpoints, and registration. MAKO is an image-based navigation system. The patient-specific model is derived from the CT scan, and only the bony anatomy is segmented. Therefore, bone registration points are collected on bone. When points are collected in regions that are covered in cartilage, the Sharp Probe is used to penetrate the cartilage and stop on the bone surface. Patient landmarks start when the arrays are fixed and visible to the camera, the leg is rotated about the hip joint in a spiral motion. Landmarks are then captured using the probe. Bone checkpoints are applied to the respective bone. Checkpoint sequences are followed by the probe in the surgeon's hand and captured. Each of the femur and tibia bone registration patterns consists of 40 points (10 groups of 4 points each). The points are critically important in setting the AP, ML, proximal/distal directions, and the axial rotation (internal/external) alignment of each bone. The registration is verified, and a measure of the overall bone registration accuracy is displayed. This is, however, not the sole deciding factor if registration passes or fails. Coloured bone spheres give a sense of registration accuracy, and this can be re-registered if not accurate.

Intraoperative planning mode allows for joint balancing, captures live limb alignment, flexion/extension angle, varus/valgus angle, internal/external rotation values. It provides a set of tools that customise the implant plan to the patient's bony anatomy. It utilises a resection-based approach because force-based gaps are not directly considered.

Ligament Balancing workflow applies proper tension to knee joint in extension and flexion. This allows surgeon to finalise the implant plan to obtain near-equal medial and lateral gaps as well as balanced flex/extension gaps. This can be performed either with tibial first cut technique or resection view which provides an indication of how bones will appear once bones cuts are complete, once decision is made bone resection is performed.

Blade and bone checkpoints are then confirmed, the robotic arm then can be moved into the zone where once aligned by the surgeon it will correct its plane. Cutting mode is set where the surgeon can depress the trigger and perform bony cuts. This will allow the saw blade to make the cuts within the boundary, outside the perimeter the saw blade will cease however if the cut is close to boundary, the boundary can be extended. However, care must be taken to ensure soft tissue anatomy is not damaged. During bone resection, the screen will change colour from green to white or red identifying the cut is performed and colour will highlight the depth of cut where red is too deep. Once visually confirmed all bone resections are complete, remove the unresected bone as required.

Implant trialling/ soft tissue balance: once bone cuts are made, resection error can be measured in CT view. Trial reduction can be assessed via spacer block or component trials. If post-resection is not as desired, the implant plan can be modified.

Once these steps are followed the final steps are performed as would be done conventionally, prepping the bone for cementation and implanting new components and closure.

Theoretical knowledge I discovered with this fellowship were alignment techniques and principles. I had the opportunity to discuss alignment techniques in total knee arthroplasty with several host surgeons. It was interesting to see different strategies that were employed during the surgeries.

Prof Haddad, employed functional alignment, placing components that least compromised soft-tissue envelope, and restored joint line obliquity dictated by soft-tissue native constitutional laxities. It works in combined principles of gap balancing and measured resection with enhanced predictive modelling, virtual implant positioning prior to bone resections, and assisted with robot-assisted platforms with optical navigation.

Some employed unrestricted kinematic alignment, his view of it being truly individualised alignment. The belief that it's a pure resurfacing, with resections based on the primary femoral transverse axis.

Other surgeons employed restricted kinematic this is mitigate the risk conferred by significant alignment outliers as per unrestricted kinematic alignment. Boundaries defined around normal alignment phenotypre from 6 degrees varus to 3 degrees valgus HKA, 6 degrees varus to 3 degrees valgus for the tibial component and 6 degrees valgus to 3 degrees varus for femoral component position.

During the surgery, we saw computer-navigated knee replacement with the surgeons' philosophy of mechanical alignment. This aligns the femoral and tibial components perpendicular to the mechanical axis of each bone segment, resulting in a neutral HKA.

This sparked my interest in reviewing other alignments i.e. Anatomic Alignment, Adjusted Mechanical Alignment, Inverse Restricted Kinematic Alignment.

In this fellowship I learnt functional or restricted kinematic alignment, no tourniquet and exploring uncemented total knee arthroplasty.

Overall, this has opened my horizons to different types of knee alignment which I had not a great understanding of. My own goals were to see setup, approaches used and, understand at least one alignment method. These goals have been surpassed. No one alignment is likely superior, and it depends on native knee alignment phenotype.

My current plans are to utilise this knowledge in my future fellowship where I will be using the MAKO and hope to continue the use of the robot in my future practice as a consultant.

This fellowship has been eye-opening into the use of robotics and how it provides real-time information that allows the surgeon to see its effects without even making the first saw cut. I would highly recommend this to anyone with an interest in robotic-assisted arthroplasty.

REPORT

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