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Registration Techniques Simplified In Computer Assisted Tumour Surgery.

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Abstract

Problem statement :-

Pelvic and proximal limb tumours face a challenge in resection and reconstruction, hence the computer assisted tumour surgery (CATS) is being commonly used. As the CATS is getting a norm in complex cases many new technology & companies have come in this domain. But the core remains dependent on quality of imaging & the registration techniques used. Many a times it becomes a tedious issue for an orthopaedic oncosurgeon to get used to the registration. Particularly the Navigation comes handy only at the late hours of the pelvic surgery.

The registration difficulties in these area are mainly because of very few bony sharp/precise landmarks available due to heavy muscular coverings. Even surface matching is quite difficult because of tissue overs bone & less obvious prominent anatomical surfaces similar to what we have in human facial surface. Hence the registration is more difficult compared to the registration of skull and facial surgeries

The solutions adapted for accurate manual registration are

1. Point based registration:-

- Prefer the CT based bony landmarks which can be precisely identified intraoperatively. Smaller the better, like an apex of a spike. (Figure 1)

- Prefer the points on the same bone getting operated. Relative movement between bones during pre-op imaging & intra-op could create accuracy issues.

- Take points around the region of interest rather than choosing the landmarks which are far from the region of interest.

- Avoid collinear points & take points in asymmetric 3 dimensional space covering the region of interest.

- Avoid taking points very near if it is not possible to cover region of interest. Points taken far provide better accuracy then the near points for the given case.

- Take help of image intensifier to identify the deep registration points

2. Surface Registration

Fiducials are quite helpful when prominent bony landmarks are not available to register region of interest properly. There are two techniques for fiducials registration.

Invasive (provides best accuracy) -

Pre imaging CT & MRI compatible titanium screw fixation on bone covering region of interest.

Non Invasive (provides acceptable accuracy)

- Fiducials which are properly visible in CT & MR can be applied across region of interest before imaging like sticking a metal fiducial on the skin. Ensuring no movement in pre-op & intra-op locations before registration.

- Mark the area outer boundary of stuck fiducials to prevent dislodgement.

- Prefer Imaging techniques in the same position as planned for the surgery (when using fiducials on patient skin). This will reduce shift of the fiducials on skin.

- Apply Fiducials in asymmetric way & minimum 10mm distance from each other.

Surface matching:-

Ensure patient surface used in 3D surface matching should resemble as close as possible the real patient surface where points are being taken.

Avoid area with soft tissues if the soft tissues are not being properly visualized on the 3D surface used for the surface registration.

Prefer bony area with prominent features while taking surface points.

Tracker placement:

Place the tracker near region of interest & on the part which will not have relative movement with respect to region of interest. Small deviation as we go far ⟶ becomes large due to lever effect.
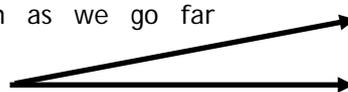
Never get distracted by RMS registration values. It is just an approximate indicator of accuracy. Always check the accuracy at the points other then used for landmark registration. Accuracy will be usually good at points which are used for registration.

Conclusion

There is no silver bullet. Based on individual case we have to titrate. By using above mentioned techniques registration accuracy can be enhanced providing better efficacy of computer assisted surgery.

Figure 1. - Precise matched registration points at the region of interest