

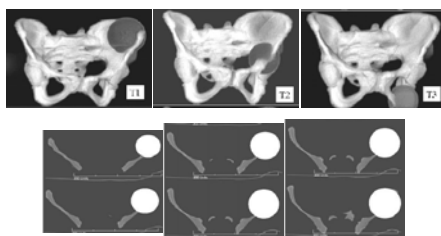
Introduction

- Treating malignant osseous tumors within the pelvis is challenging due to the complex anatomy of the pelvis. Nowadays, one of the most satisfactory solutions is a large resection combined with reconstruction by massive allograft.
- No experimental data exist about the accuracy of pelvic tumor resection using conventional technique. This lack of data renders difficult performance evaluation of computer and robotic assisted technologies.
- This experimental study tends to report the accuracy of tumor resection within the pelvis and reconstruction by massive allograft with conventional surgical technique. An experimental model on sawbones was designed.

Material & Methods

- 4 experienced surgeons (Surg1, Surg2, Surg3, Surg4) were each asked to perform resection of 3 different pelvic tumors and their reconstruction. 12 identical pelvic Sawbones and 12 left hemipelvic Sawbones were considered as host bones (host) and allografts (graft) respectively.

Fig. 1 : The 12 hosts were scanned. 3 sets of tumor were virtually created : tumor 1 in zone I (iliac wing), tumor 2 in zone II (acetabulum), and tumor 3 in zones II-III (acetabulum and obturator foramen) according to Enneking and Dunham.

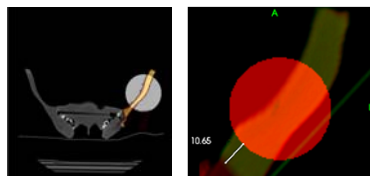


- Surgeons could plan and perform resection of the 3 tumors without limitation in time. Instruction was given to respect as accurately as possible a 10mm-safe margin. They could note some landmarks with a skin marker on the Sawbone to guide the cutting.



Fig. 2 : Sawbone was rigidly fixed by a steel clamp with a 360° - rotational base. Cutting was performed using an oscillating saw.

Fig. 3 : Resected parts were scanned and registered with the host 3D CT-scan. The minimal distance between tumor and resection planes was measured.



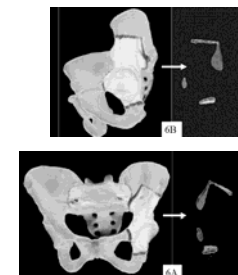
- Each surgeon had to reconstruct the 3 pelvis. Oversized grafts were given to increase technical difficulty. Surgeons could note some landmarks to guide the cutting of the graft. Host-graft reconstructions were temporarily osteosynthesized with 2mm K-wires.

Fig. 4 : Host-graft junctions were classified according to the degree of contact : degree 1 for full contact, 2 for contact > 50%, 3 for contact < 50% or 4 for no contact.



Fig. 5 : Maximal gap between host and graft was measured with an electronic caliper.

Fig. 6 : An epoxy paste of high density was used to fill the gap. All the constructs were scanned. The number of voxels corresponding to the paste were calculated, giving the gap volume between host and graft.



Results

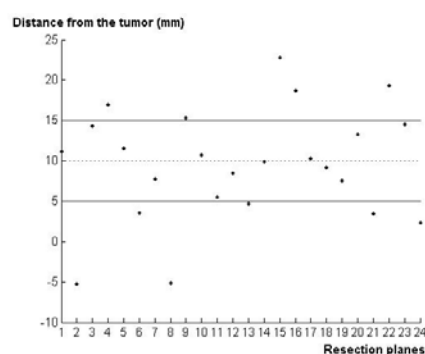


Fig. 7 : Mean error on the recommended 10 mm-surgical margin was 5.27mm (± 4.42). 11 resection planes were out of the accepted 5 mm-tolerance. 2 resections were intralesional.

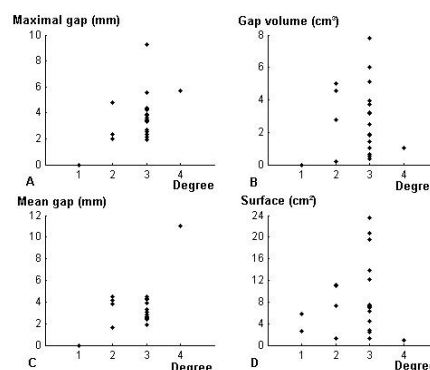


Fig. 8 : Maximal gap, gap volume and mean gap between host and graft were in mean 3.31 mm (± 1.93), 2.74 cm³ (± 2.10) and 3.22 mm (± 2.08), respectively. Correlation between reconstruction measures was poor.

Discussion

- 4 experienced surgeons did not manage to consistently respect a fixed surgical margin under ideal working conditions. Inaccuracy during tumor resection can thus be explained by the anatomy of the pelvis. Our study is the first to experimentally quantify this overall inaccuracy.
- There is a need either to increase the surgical margin or to use computer-assisted technologies in tumor resection and in cutting of the allograft. Data presented in this study could be useful for further evaluation of computer and robotic assisted technologies.
- Our attempt to evaluate pelvic reconstruction using simple geometrical parameters of the host-graft junction, was not satisfactory.
- There is a need to define standards of evaluation on geometrically simpler structures. Mechanical engineering tools, like geometrical tolerances and mechanical fittings, could be well adapted to this problem.

Collaboration :

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