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Computer-assisted planning and patient-specific instruments for bone tumor surgery within the pelvis – an experimental study.

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Background
Resecting bone tumors within the pelvis is highly challenging but requires good cutting accuracy to achieve sufficient margins. Computer-assisted technologies such as intraoperative navigation have been developed for pelvic bone tumor resection. Patient-specific instruments, mainly used for arthroplasty, have been transposed to tumor surgery. This experimental study investigated the accuracy of patient-specific instruments for bone cutting during simulated tumor surgeries within the pelvis.

Methods
The experimentations were conducted using synthetic hemipelvic bones (Sawbones). The hemipelvis was CT-scanned to produce a 3D model. A spherical tumor was simulated on the acetabulum. Four cutting planes have been positioned around this tumor including a 10-mm safe margin (Fig.1a). Three bone-specific instruments have been designed (Fig.1b). Their bone-specific surface permitted to fit in unique position on the pelvic model. The flat surface materializes the targeted cutting plane. The instruments were manufactured using rapid prototyping technology. Eight experienced surgeons were asked to perform the tumor resection.
Each performed cut plane was digitized using a coordinate measuring machine (Signum® SL, Mycrona). The accuracy was estimated using the location (maximum distance between the performed and target planes) and the surgical margin (minimum distance between the performed plane and the tumor). The operative time required for the whole tumor resection was recorded.

Results
The location of the performed cut planes with respect to the target planes averaged 1.84 mm [1.31;2.36]. The achieved surgical margins averaged 10.23 mm [9.78;10.67]. The maximum error on achieved surgical margins was 3.12 mm. None of the resections were intralesional. The time required for the resection averaged 6.46 minutes.

Conclusion
This experimental study reports a satisfying accuracy when using patient-specific instruments during cutting of a simulated pelvic bone tumor. The location data demonstrate how patient-specific instruments may help to replicate a preoperative resection planning on a pelvic structure with a good accuracy. The time required for resection shows that this technology is easy to use and does not require a heavy set-up in the operating room. Patient-specific instruments may improve bone tumor surgery within the pelvis and other locations by providing clinically acceptable margins.

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