Crio2AR – Effectiveness of cryotherapy and preoperative planning using Augmented Reality for the treatment of Giant Cell Tumor of bone

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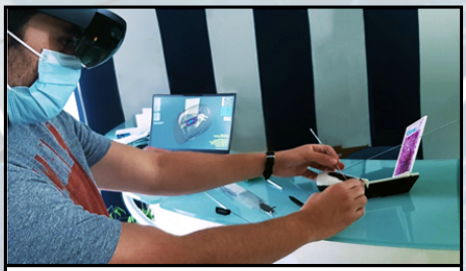
INTRODUCTION

Giant Cell Tumour (GCT) of Bone represents about 5% of all primitive bone tumours, and about 20% of the benign ones (even if <1% of the cases spreads metastasis).
It most commonly affects female subject between age 20 to 40 and it mainly localizes in the meta-epiphyseal region of long bones having the knee as the most targeted localization. GCT of bone is characterized of high local aggressiveness and a high rate of recurrence. In order minimize the risk of recurrency, aggressive surgical solutions may be carried out (i.e wide curettage) producing important functional limitation. Even after aggressive surgery the recurrence rate is about 1-12%.
For these reasons, intraoperative adjuvant treatments has been emplyed over the years, such as the use of phenol, peroxide, PMMA and cryotherapy.
As for cryotherapy, the ice probes localization has not been standardized yet. Crio2AR is an ongoing study accepted and funded by the Tuscany region which should provide the surgeon the possibility of planning the probe positioning using both 3D printed reconstrucion and AR technology.



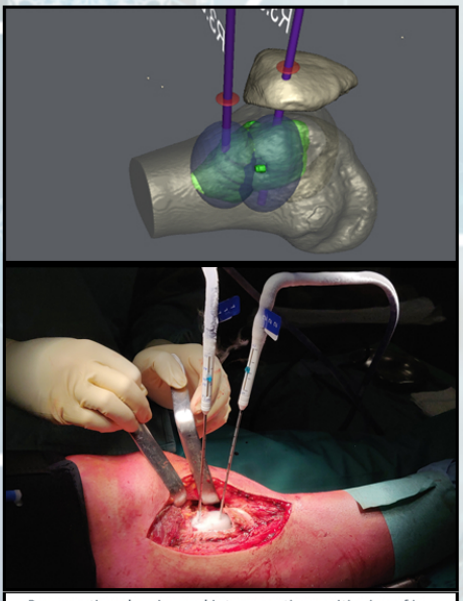
Testing probe positioning while using HoloLENS and AR

STUDY DESIGN & METHODS

Our study is a prospective randomized, controlled, two-arm treatment in which are compared patients treated with adjuvant cryotherapy after standard preoperative planning vs AR technology and 3D reconstruction planning.
Both groups are composed by 5 patients and for each of them is required pre-operative MRI and CT-scan. The recruitment phase at the last update counts 6 patients and for 3 of them there has been made an AR pre-operative planning.
In the two groups we are evaluating invasivity of surgeon procedure, surgeon procedure quality using a LIKERT survey, patient's quality life using the EORTC QLQ-C30 questionnaire and post-operative pain measured by NRS.
The AR planning has been made possible by the collaboration with the EndoCAS research group of the University of Pisa.
Based on the preoperative CT study it has been made a 3D virtual model allowing the ice probe positioning. The same virtual simulation is then used to create an AR model which can be visualizes with the HoloLens system and matching at the same time a 3D printed model.
Clinical and instrumental (x-rays and MRI) follow-up has been conducted at 2-6-12 months after the surgical procedure.
The two groups will at last be compared with a third group obtained from our surgery GCT casistics of patients treated without cryotherapy.

RESULTS

Our patients' mean age is 36.8 years (20 to 52). Four of them have completed a 12 months follow-up showing an absence of local recurrence.
Regarding the use of AR technology in preoperative planning, this was used in three patients (one of them has successfully completed the follow-up).
Surveys proposed to the surgeons who used this technology showd they were entusiastic about the experience.
Hololens system is wearable and comfortable. UI of the software used for the AR is user friendly, intuitive and easy going so it has been reported an excellent UX. Thanks to the AR planning surgeons could visualize not only the position of the ice probes, but even the exact size of the pathological tissues that would be resected and the actual effect of the probe placement during surgery.



Preoperative planning and intraoperative positioning of ice probes for case n.7

CONCLUSION

The use of AR technology could enable our surgeons to better study the surgical procedure and get better prepared. Thus, knowing in advance the best location for probe placement should allow to request the appropriate probe type and to estimate the number of cryotherapy cycles that should be taken. For these reasons we expect the final results to confirm the good preliminars one.