DOI: 10.5212/Publ.Biologicas.v.23i1.0007

HEPATIC 3D MODEL AS AN ADJUVANT IN THE PLANNING AND SURGICAL TREATAMENT OF INTRAHEPATIC COLANGIOCARCINOMA – CASE REPORT

MODELO HEPÁTICO 3D COMO ADJUVANTE NO PLANEJAMENTO E TRATAMENTO CIRURGICO DE COLANGIOCARCINOMA INTRA-HEPÁTICO - RELATO DE CASO

Camila Aparecida Moraes Marques[1,2*], Kassia Cordova[3], Isabelle Guth[3], Carlos Francisco Pardal[3], Luiz Claudio Fernandes[4], Henrique Wiederkehr[4], Julio Wiederkehr[4], Caroline Aragão[4], Barbara Wiederkehr[3], Luiz Fernando Kubrusly[3]
[1]Instituto Denton Cooley, Curitiba, Paraná, Brasil, [2]Centro Universitário Autônomo do Brasil, Curitiba, Paraná, Brasil, [3]Faculdade Evangélica do Paraná, Curitiba, Paraná, Brasil, [4]Universidade Federal do Paraná, Curitiba, Paraná, Brasil

[*]Autor correspondente: camilam14@gmail.com

RESUMO

O colangiocarcinoma intra-hepático é um tumor proveniente do epitélio biliar e, apesar de raro, é considerado o segundo tumor maligno primitivo mais prevalente no fígado logo após o carcinoma hepatocelular. Além disso, está associado a uma elevada taxa de mortalidade e a ressecção cirúrgica é a única possibilidade de cura. A ressecção cirúrgica do colangiocarcinoma intra-hepático está associada com uma taxa de sobrevida, em 5 anos, de cerca de 22-36%. As imagens pré-operatórias, tomografia computadorizada e/ou ressonância magnética, são instrumentos fundamentais para o planejamento cirúrgico. Devido à alta complexidade das anatomias hepática e vascular intra-hepática, a realização da manobra de ressecção nesse contexto constitui-se um grande desafio. Assim sendo, a tecnologia de impressão 3D tem sido lentamente implementada na área de cirurgia geral. Frente ao exposto, o objetivo deste estudo foi relatar uma forma de emprego da tecnologia de impressão hepática tridimensional, visando o planejamento e o tratamento cirúrgico de um colangiocarcinoma intra-hepático.

ABSTRACT

Intrahepatic cholangiocarcinoma is a tumor from biliary epithelium and, although rare, it is considered the second most prevalent malignant liver tumor, right after hepatocellular carcinoma. It is associated to a high mortality rate, and surgical resection is the only alternative of cure. Surgical resection of intrahepatic cholangiocarcinoma is associated with a 5-year survival rate about 22-36%. Preoperative images, computed tomography and/or magnetic resonance imaging are fundamental tools for surgical planning. Because of the complex nature of hepatic and intrahepatic vascular anatomy, resections are challenging surgeries. 3D printing technology has been slowly adopted in general surgery. This study aimed to report the use of three-dimensional hepatic printing in planning and surgical treatment of an intrahepatic cholangiocarcinoma.
Keywords: hepatic prototype, cholangiocarcinoma, hepatic resection.

INTRODUCTION

More specifically, intrahepatic cholangiocarcinoma is a tumor from biliary epithelium, and, despite being rare, it is considered the second most prevalent primitive liver tumor, second only to hepatocellular carcinomaogo. In the initial phases, this illness presents unspecified clinical condition, making it hard to diagnose it precociously, with image exams being essential for the diagnosis. Besides that, a deth rate may occur in Intrahepatic cholangiocarcinoma cases, while surgical resection is the only possibility of cure (SHIMODA & KUBOTA, 2007).

In this context, surgical resection is associated to a five-year survival rate in approximately 22-36%. These low survival rates have been related to the difficulty in the discovery of the real size of the wound. Even though results, after resection, have advanced in recent years, new advances are still necessary. (SHIMODA & KUBOTA, 2007; JAMAGIN & SHOUP, 2004).

Pre-surgical images, computed tomography and/or magnetic resonance imaging, are essential tools for the surgical planning, since they make it possible to document the tumors spread, to estimate the remaining liver volume post-surgery, and to identify the relation between the tumor and the vascular anatomy (SOON et al., 2006). However, 3D images, when analyzed in 2D format, do not allow for perfect anatomy comprehension, besides that, the surgeon has to mentally reconstruct the image in a tridimensional form.

Due to the high complexity of the liver and intrahepatic vascular anatomy, achieving resection in this context constitutes a major challenge. The 3D printing technology has been slowly implemented in the area of general surgery. The 3D liver printing technology appears to be a promising tool for the surgical planning and treatment of some serious diseases that can affect this organ (SOON et al., 2006).

Several authors suggest that the 3D prototypes allow a better understanding of the vascular anatomy, bile duct and adjacent parenchyma when compared with conventional computed tomography or magnetic resonance imaging. Besides that, they allow the surgical team a three-dimensional and full-size visualization of the lesion, in addition to reproducing anatomical models based on the individual characteristics of each patient (SOON et al., 2006; HORI et al., 2011; FRERICKS et al., 2004; ZEIN et al., 2013).

Thus, the objective of this study was to report the use of three-dimensional hepatic impression in the planning and surgical treatment of an intrahepatic cholangiocarcinoma.

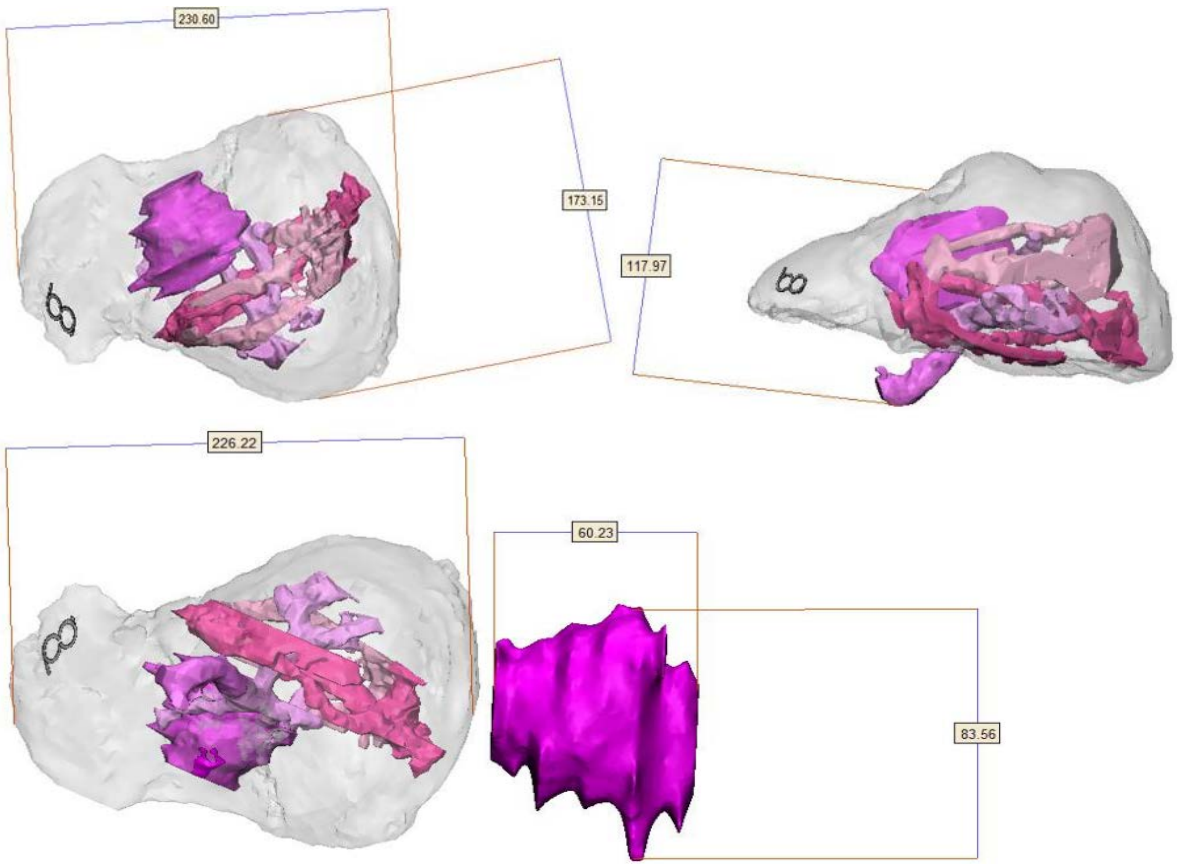
CLINICAL CASE

A 70-year-old male patient, resident in São Bento (SC), sought private care with a history of abdominal pain varying from mild to moderate, persistent, for 14 days, associated with weight loss of 6 kg in 30 days, without other signs or symptoms.

Routine laboratory exams were requested, which did not show changes. However, total abdominal ultrasonography revealed an 8mm dilatation in intrahepatic bile ducts associated with a mass localized in segment B (IVB) of the liver of 60.23x83.5mm. We requested laboratory tests that identified hemoglobin (Hb) of 11.8 g / dL, hematocrit (Ht) of 36%, platelets of 190,000 / mm³, total leukocytes of 6,200 / mm³, Alanine-transaminase (ALT) of 45U / L, aspartate (TG) of 72U / L, total bilirubin (BT) of 1.2mg / dL, indirect bilirubin (BI) of 0.3 mg / dL, direct bilirubin (BD) of 0.9mg / dL, CA 19-9 of 28U / ml, CEA of 1.0mcg / L and alpha-fetoprotein of 2mcg / L. A magnetic resonance cholangiography was performed, contrasting with the use of parenteral gadolinium, which showed a mass with the same dimensions observed in the total abdominal ultrasound (60.23x83.5mm) and with involvement of the intrahepatic bile ducts in the IVB segment of the liver, without invasion of the portal vein, without involvement of lymph nodes and without metastases to adjacent organs. The patient was diagnosed with stage I intrahepatic cholangiocarcinoma (T1N0M0).

Based on the performed cholangioron resonance, a prototype was developed with a 3D printer, in partnership with BioArchitects (a São Paulo company of medical technology) that portrayed the patient's picture. The prototype was developed using photosensitive polymer, Objet Studio software, and for 3D printing PolyJet technology was used. The tumor and related structures were made with different stains. The time for prototyping was 37 hours and the cost was R$ 6,500.00 reais ($ 1,971.60 dollars) (Pic.1). Therefore, the prototype allowed a three-dimensional visualization of the spatial relationship between tumor, vascular anatomy and liver biliary tract. This prototype was sterilized and was available in the operating room.

Picture 1: Prototype of the patient's liver



For surgery, the patient was anesthetized and prepared based on his anatomical characteristics due to the prototype analysis. During the procedure it was evidenced a tumor in segment IVB of the liver with partial invasion for segment V and caudate lobe, tumor next to hilar plaque, but without invasion of it. The left hepatic lobe was then resected with the use of ultrasonic scalpel and parenchymal vessel ligation. Although challenging, the procedure was performed successfully, and the postoperative procedure did not present c complications.

The surgical specimen was submitted to histopathological analysis, using hematoxylin-eosin stain, which revealed a moderately differentiated adenocarcinoma type cholangiocarcinoma (G2 stage), composed of epithelial cells with granular eosinophilic cytoplasm. Resection was successful with negative histologically surgical margins.

DISCUSSION

Cholangiocarcinoma accounts for 3% of carcinomas of the gastrointestinal tract, so its incidence is 0.01-0.8%. More specifically, CCIH is responsible for about 10% to 20% of primary malignant liver tumors, with a higher incidence in men, in addition to being associated with a high mortality rate. The cause of CCIH is unknown, it is believed that chronic inflammation of the biliary tract, primary sclerosing cholangitis and biliary stenosis may be predictive factors (SHIMODA & KUBOTA, 2007).

Treatment depends on several factors such as tumor extension, vascular invasion, presence of metastases, basal liver function, comorbidities and patient conditions. Routine images such as ultrasound, cholangiography, abdominal and chest tomography, as well as laboratory analysis are fundamental for diagnosis (SHIMODA & KUBOTA, 2007).

Complete surgical resection with negative margins is the only curative treatment. The tumor-free surgical margin is considered the best survival predictor. Preoperative staging is fundamental to determine the applicability of the surgical procedure, since most patients present the disease in an advanced state (Shimoda & Kubota, 2007; RIECHELMANN et al., 2016).

A major concern with regard to surgical resection is the volume of liver remaining. Patients with other comorbidities such as cirrhosis have a reduced physiological reserve, which impairs the body's resistance to large resections. Detailed preoperative planning is essential to minimize resected hepatic volume and to prevent postoperative liver failure (SOON et al., 2006).

The 3D models may be useful to assist surgeons in the evaluation and surgical planning in order to improve the safety of hepatectomies, as it allows the execution of approaches that optimize the remaining liver volume and the management of patients with anatomical variations (SOON et al. , 2006; XIANG et al., 2015). Technology with 3D models has provided breakthroughs in the medical sciences. However, the use of 3D printing in hepatobiliary surgeries is still little explored in medical literature and clinical practice. (ZEIN et al., 2013).

According to the analyzes, the 3D printing propitiate more adequate preoperative, a greater safety in the surgical resection of the tumor, since with the model it is possible to visualize in a three-dimensional way the spatial relations between the tumor, and the vascular and bile duct structure of the patient. We also had a subjective perception that the use of this tool decreased the preoperative time and, consequently, made it more suitable, since it allowed the visualization of the spatial relations of the tumor and its possible complications, which could not be foreseen only with analysis of dimensional images, minimizing operative complications.

This, in turn, allows a better approach to anatomical variations at the time of surgery. In addition, the different stains of the prototype facilitated the visualization and identification of these elements.

Therefore, the use of this technology can probably be an alternative to intraoperative ultrasonography to determine the hepatic resection line, since the use of the prototype allows simulating the limits through different angles, as well as allowing the positioning of the model in the desired way (ZEIN et al., 2013, OSHIRO et al., 2016, IGAMI et al., 2014). Other positive points are also the facilitation of the interaction between the doctor and the patient during the explanation of the procedure and in the process of consent; and may also assist students and surgeons with little experience in understanding the spatial relationships between tumors and vascular anatomy (SOON et al., 2006; OSHIRO et al., 2016). The main limitations cited in the literature are the cost and time to manufacture the prototype (SOON et al., 2006; ZEIN et al., 2013, XIANG et al., 2015 OSHIRO et al., 2016, IGAMI et al. 2014).

CONCLUSION

Reproduction of a 3D hepatic prototype based on the individual characteristics of each patient is feasible, allowing a more accurate planning and facilitation for resection of intrahepatic cholangiocarcinoma. This instrument appears to be promising for the execution of maneuvers in the context of hepatobiliary surgery.

Ethical considerations: this paper does not require the presentation of a free and informed consent form, since the patient was not submitted to any new intervention, in addition to which there will be no impairment and / or alteration of therapeutic behavior due to this study.

REFERENCES

FRERICKS, Bernd B. et al. 3D CT modeling of hepatic vessel architecture and volume calculation in living donated liver transplantation. **European radiology**, v. 14, n. 2, p. 326-333, 2004.

HORI, Masatoshi et al. Computed tomography liver volumetry using 3-dimensional image data in living donor liver transplantation: Effects of the slice thickness on the volume calculation. **Liver Transplantation**, v. 17, n. 12, p. 1427-1436, 2011.

IGAMI, Tsuyoshi et al. Application of a three-dimensional print of a liver in hepatectomy for small tumors invisible by intraoperative ultrasonography: preliminary experience. **World journal of surgery**, v. 38, n. 12, p. 3163-3166, 2014.

JARNAGIN, William R.; SHOUP, Margo. Surgical management of cholangiocarcinoma. In: **Seminars in liver disease**. Copyright© 2004 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA., 2004. p. 189-199.

OSHIRO, Yukio et al. A novel three-dimensional print of liver vessels and tumors in hepatectomy. **Surgery Today**, p. 1-4, 2016.

RIECHELMANN, Rachel et al. GUIDELINE FOR THE MANAGEMENT OF BILE DUCT CANCERS BY THE BRAZILIAN GASTROINTESTINAL TUMOR GROUP. **Arquivos de gastroenterologia**, v. 53, n. 1, p. 5-9, 2016.

SHIMODA, Mitsugi; KUBOTA, Keiichi. Multi-disciplinary treatment for cholangiocellular carcinoma. **World journal of gastroenterology**, v. 13, n. 10, p. 1500, 2007.

SOON, David SC et al. 3D haptic modelling for preoperative planning of hepatic resection: A systematic review. **Annals of Medicine and Surgery**, v. 10, p. 1-7, 2016.

XIANG, Nan et al. Application of liver three-dimensional printing in hepatectomy for complex massive hepatocarcinoma with rare variations of portal vein: preliminary experience. **International journal of clinical and experimental medicine**, v. 8, n. 10, p. 18873, 2015.

ZEIN, Nizar N. et al. Three-dimensional print of a liver for preoperative planning in living donor liver transplantation. **Liver Transplantation**, v. 19, n. 12, p. 1304-1310, 2013.