necessity for intervention? Magnetic resonance imaging is capable of resolving the internal character of necrotic collections into mixtures of fluid and necrotic components,[8] while CT, as used in this study, lacks this capability. Is it possible that WON with a disproportionate amount of fluid over necrotic material might have a greater tendency to regress? Further, would continued untreated follow-up longer than the 3 months in the current study provide us more information regarding frequency of regression, and therefore reduce the indications for intervention? Data exist to lead us to believe that this might be so.

As with any good study, the report from our Indian colleagues raises as many questions as it answers. Indeed, the management controversy regarding WON highlighted in this letter could be summarized as "Anything worth doing is worth overdoing!" versus "Don't just do something, stand there!" Most likely, the truth lies somewhere in-between, and is yet to be determined.

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Response to the Comment on "Outcome of Acute Pancreatic and Peripancreatic Collections Occurring in Patients With Acute Pancreatitis"

Reply:

The queries regarding intervention in walled off necrosis (WON) brought forward by Professor Edward L. Bradley III are very relevant. Due to the word limit constraints during initial submission, we were unable to explain certain aspects of our study in detail. Infected necrosis (IN) was suspected by the patient's worsening clinical course or by the presence of gas within the necrosis seen on CECT. Infection of pancreatic necrosis was established by culture of drain fluid. The indications for percutaneous catheter drainage (PCD) were as per established criteria, that is, persistent organ failure, IN, and/or pressure symptoms (persistent pain, biliary obstruction, gastric outlet obstruction). The first aspirated fluid sample was transferred to bacteriology laboratory for culture. In the event of no improvement within 72 hours, the catheters were upsized to a maximum of 18 Fr or additional drainage was placed for any residual collection(s). The antibiotic therapy was modified according to the culture sensitivity report and continued for at least 10 to 14 days. All patients were followed up clinically and radiologically till the defined study period. Patients who failed to recover or worsened with medical management and PCD were subjected to surgical necrosectomy.

As per the currently used "step up" approach in the management of AP,[1] PCD is successful in up to 50% of patients with infected necrosis, avoiding surgical necrosectomy in over half of the patients. Most of the current guidelines recommend against invasive intervention until the collection is walled off.[1,2] The Dutch Pancreatitis Study Group has reported that longer the time between admission and intervention (both surgical and nonsurgical), the risk of mortality is lower: 56% within 0 to 14 days; 26% within 14 to 29 days, and 15% after 29 days.[2] The rationale for delayed percutaneous or endoscopic drainage is that some patients might improve with antibiotics only and catheter drainage might be easier in the WON as collections become more liquefied with time.[3] Indeed, Baudin et al showed that among patients who underwent PCD, those who ultimately survived had onset-to-PCD interval of 23 days, compared with those who died having onset-to-PCD interval of 13 days ($P = 0.04$).[4] In an international expert survey, 55% of pancreatologists agreed to postpone PCD in IN using antibiotics, whereas the other 45% agreed to drain immediately.[5]

Keeping the discussion in perspective, in our study[6] a total of 54 patients underwent PCD insertion. Among these, 57% patients had persistent infected collection/necrosis as the indication of drainage. Persistent organ failure was the indication in 26% patients and persistent SIRS was the indication in 17% patients. Among the 24 patients who underwent surgery, 13 had IN, 5 had failed management with antibiotics and PCD, 4 were unresponsive to antibiotics and other supportive care, and 2 had gastrointestinal bleed. Thereafter, a quarter of ANCs resolved spontaneously by 4 weeks, whereas 58.7% evolved into WON. We found that of the 84 patients with WON followed up for 3 months, 53 required an intervention, whereas Patra et al[7] observed that only 40% of their patients with WON required an intervention. This divergence may be explained by a higher proportion of patients with organ failure and necrosis >30%, suggesting more severe disease in our study.

As mentioned by Professor Edward L. Bradley III in his previous study[8] of 194 patients, pancreatic necrosis developed in 38 (20%), which was subsequently confirmed by histologic diagnosis at surgery in 28 patients. Among the patients with pancreatic necrosis who remained persistently febrile, IN was demonstrated in 27/38 (71%), who were treated by open drainage. The number of patients with pancreatic necrosis was only 20% reflecting that the disease was mild in a majority of them, and intervention was required in those with IN, implying that in the remainder of patients (predominantly mild disease) spontaneous resolution was the norm. On the contrary, our study[6] had 88% patients with moderate and severe AP. These subgroups of AP tend to have more local complications especially fluid collection and hence increased requirement of intervention. We absolutely agree with Professor Bradley that for sterile as well as asymptomatic collections, a "wait and watch" policy may be followed and intervention may be delayed or avoided, as was followed in our study. However, when mandated by clinical situations and established indications of drainage, idle wait may be harmful.

Another issue which needs deliberation is that whether imaging can help in improving the decision-making in the management of WON. CT scan is limited by its inability to quantify solid component of the WON. Endosonography and magnetic

resonance imaging are better in defining solid versus liquid contents of WON.[9] However, the mere presence of more solid contents in a WON would not warrant PCD or any intervention for that matter. The indications of PCD would remain the same, that is, IN, persistent organ failure or pressure symptoms.

We reiterate the fact that the decision to intervene would solely be decided by the course of the disease, presence of IN or pressure symptoms, response to antibiotics, and other conservative management and presence of other uncommon complications.

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Comment on "Mixed Reality in Visceral Surgery: Development of a Suitable Workflow and Evaluation of Intraoperative Usecases"

To the Editor:

Digital images applied to surgery are one of the most promising fields of the next decade. Further steps in computer-assisted surgery like the autonomous or semiautonomous robots need image integration to become possible. For this reason, we warmly congratulate Sauer et al[1] for their effort to develop a reliable way to get images guidance for open liver surgery. However, we would like to point out few aspects of their study, to clarify the real state of the art, avoiding the scientific community to have unsustainable short-term expectations.

We already discussed on this journal how important is to use a flawless terminology when speaking about computer science and virtual reality in surgery.[2] The authors properly defined virtual reality as a continuum from a total computer-generated environment to the coexistence of real and virtual images. Moreover, Sauer et al defined mixed reality the subfield of virtual reality where digital images are spatially correlated with the real digitalized subject. The issue is all in this subtle but essential concept, since the spatial correlation is the key to reach image fusion (IF). IF is defined as the process to integrate complementary multisensor, multitemporal, and/or multiview information into one *new* image, which cannot be achieved otherwise. The authors presented their use of head mounted display (HMD) to make preoperative images available for the surgeon in a smart way, without the physical limitation of external screens. Having the real surgical target and its interactive digital reconstruction in the same visual field (not superimposed) can be useful, but is not a true step toward IF. The 3D shape of the liver in the preoperative computer tomography scan varies during surgical manipulation, requiring the digital reconstruction done from the first to be adaptable to the latter, using fixed landmarks and tissue deformation simulation. This is the missing step and the reason why we would prefer to reserve the term Mixed Reality for this possible future scenario.

We agree on the potential role of the 3D ultrasound as the best real-time imaging for hepatic surgery. In their Figure 4, Sauer et al presented just a simulation (not available so far), while the HMD view looks not different from the tile-pro image a robotic surgeon can get in his or her console (Fig. 4A). For the aforementioned reasons, IF is extremely challenging in hepatic surgery. Experimental models tried to reach IF mimicking hepatic lesions in a gel-based simulated liver, but primarily using real-time ultrasound (US).[3] More interesting in this direction are the US–US fusion experience by Minami et al[4] for radio-frequency ablation in the liver or the MRI–US merging done for prostatic biopsy.[5]

Moreover, the definition of "suitable [data] workflow" does not seem to match with the use of a sequence of 5 different software, almost all designed for other purposes. A customized, simplified workflow should be preconized for a daily practice use. Therefore, presented results do not represent in our opinion a progression of the state of the art in this field.

In summary, we consider accurate to define as Augmented Reality Sauer et al's experience, reserving the term Mixed Reality for future IF scenarios. However, we agree in considering HMD as the best place for image integration in open and laparoscopic surgery, removing this peculiarity (a virtual environment for computational help) from the robot.

Dr. Gheza is a consultant for Medtronic. Dr. Raimondi has nothing to disclose.

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