Is the Pringle manoeuvre becoming a lost art? Contemporary use for both severe liver trauma with ongoing hemorrhage and elective partial hepatectomy

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Summary

The Pringle manoeuvre (vascular inflow occlusion) has been a mainstay technique in trauma surgery and hepato-pancreato-biliary surgery since it was first described in the early 1900s. We sought to determine how frequently the manoeuvre is used today for both elective and emergent cases in these disciplines. To reflect on its evolution, we evaluated the Pringle manoeuvre over a recent 10-year period (2010–2020). We found it is used less frequently owing to more frequent nonoperative management and more advanced elective hepatic resection techniques. Continuing educational collaboration is critical to ensure continued insight into the impact of hepatic vascular inflow occlusion among trainees who observe this procedure less frequently.

Cross-pollination of ideas among surgical subspecialties is notoriously underexploited. Since its initial description in 1908, however, the Pringle manoeuvre — vascular inflow occlusion — has remained a mainstay technique within 2 distinct fields: trauma surgery and hepato-pancreato-biliary (HPB) surgery.[1] More specifically, it is a critical early diagnostic and potentially therapeutic step in addressing massive liver-related hemorrhage following trauma.[2,3] For decades, it has also been central to reducing blood loss, and therefore blood product transfusion, during elective hepatectomies.[4]

In trauma scenarios, the Pringle manoeuvre is applied to occlude the porta hepatis (i.e., hepatic arterial/portal venous inflow) on a rapid basis if initial organ reconstitution and perihepatic packing fail to arrest ongoing hemorrhage.[2] Independent of effect, use of the Pringle manoeuvre provides the trauma surgeon with significant information, prompting them to move forward to the next step.[2,3] In cases of elective hepatic resection, the Pringle manoeuvre has classically been engaged to either prevent ongoing bleeding during parenchymal transection, or as a response to brisk hemorrhage during the resection.[4] Interestingly, with the widespread use of both novel energy devices[5] and low central venous pressure anesthesia,[6] the requirement for Pringle manoeuvre engagement has seemingly decreased over time. In an attempt to reflect on this evolution, we evaluated the Pringle manoeuvre over a period of 10 years (2010–2020) in both HPB and trauma surgeries.

Chart summary

Of 11 005 severely injured patients, 101 had high-grade hepatic trauma as defined by the American Association for the Surgery of Trauma (AAST) liver injury grading scale (598 total liver injuries). Of the 30% who required operative hepatorraphy, 21 (70%) received a Pringle manoeuvre (v. 2.4% in patients with low-grade injuries). Pringle occlusion averaged

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27 minutes (v. 14 minutes in patients undergoing elective resections). Interestingly, the use of on/off intervals to allow the quenching of the liver was uncommon among trauma cases (8 of 21 [38%]). While this may potentially reflect a fear of repeated torrential hemorrhage if unclamped, or a lack of familiarity with nuanced Pringle techniques in trauma cases, consideration of intermittent unclamping may reduce the risk of subsequent liver ischemia–related complications. Instruments included Rumel tourniquet, vascular clamp, vessel loop, knotted Foley catheter, and a delicate occlusive hand (v. Rumel tourniquet for all elective resections). Of the patients with grade IV/V injuries, 6 (20%) developed postinjury hepatic failure (3 died). Among 44 patients who died, 2 deaths were related to ongoing hepatic-related hemorrhage. Among 631 patients who underwent elective open liver resections (segmental [56%], lobectomy [33%], mesoaxial [11%]), Pringle manoeuvres were applied 38 (6%) times. Postresection liver failure occurred in 5 patients (1 died of uncorrectable posthepatectomy liver failure).

Discussion

The goal of the Pringle manoeuvre is to occlude all vascular inflow to the liver from both the hepatic artery and portal vein. It must be noted, however, that this manoeuvre does not completely eliminate flow through (or within) the liver. Tremendous residual blood flow occurs from the inferior vena cava (IVC) via direct branches between the IVC and liver; the suprahepatic hepatic veins; and within the liver itself, given its vast intraparenchymal cross-circulation and large volume reservoir. This reality forms part of the rationale for pursuing total vascular exclusion (TVE) of the liver when necessary.[2]

Although nuanced Pringle technique is frequently discounted, the most rapid manner for positioning a device around the porta hepatis involves a large thoracic right-angled clamp. This is placed from medial to lateral with the operator's right hand (assuming the primary surgeon is positioned on the patient's left), while the left hand (above the pancreatic head/duodenal complex) pulls the porta hepatis caudally. This approach minimizes trauma to the medial porta hepatis and its nearby structures (hepatic artery, gastroduodenal artery, pars flaccida, pancreatic head and neck, duodenum, distal stomach, caudate liver). The surgeon's left hand (or assistant) then places the umbilical tape/tube into the tip of the thoracic clamp, which is then carefully pulled back and secured. It is important to use educated fingers to avoid creating additional trauma in this very anatomically intense region.

The ability of a patient's liver to tolerate Pringle manoeuvre–associated ischemia also varies substantially between those undergoing elective liver resections (typically intermittent clamping) and those with major hepatic trauma (typically continuous clamping with pre-existing/concurrent hypotension and patients approaching physiologic exhaustion). The higher rate of postprocedural liver failure among severely injured patients (21.7% v. 2.6%) reflects the preprocedural physiology and massive ongoing hemorrhage occurring before application of the Pringle manoeuvre. Despite youth and less frequent chronic liver disease, injured patients require longer clamp times and are at higher risk of hepatic ischemia.

It is clear that the overall use of the Pringle manoeuvre has decreased over time. In trauma, this reflects a shift toward nonoperative management.[2,7] In elective hepatectomy, this coincides with the transition to new energy instrumentation for parenchymal dissection/transection,[8] as well as dedication to low central venous pressure anesthesia.[6] More specifically, Pringle occlusion in our elective hepatectomies performed during the past decade was 6.0% and reserved for scenarios to control "unwanted" hemorrhage (i.e., not to pre-empt bleeding). Interestingly, only 2.1% of patients received a Pringle manoeuvre within the past 5 years (v. 21.2% in the 5 years before the study period). This observation is interesting, considering the ongoing debate in the literature regarding the true effect of the Pringle manoeuvre on blood loss/transfusions as well as liver ischemia.[4,9] Despite its use in more complex cases (malignancy, larger/open resections, neoadjuvant therapy, liver disease), there appears to be no difference in blood loss, rate of transfusion, morbidity, or mortality despite a decrease in liver parenchymal transection time.[4,9]

Conclusion

The Pringle manoeuvre may now be more frequently applied in trauma surgery than HPB surgery. Continuing educational collaboration between trauma and HPB surgeons is critical to ensure nuanced Pringle technique and insight into the impact of hepatic vascular inflow occlusion among trainees who observe this procedure less frequently.

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References

1. Pringle JHV. Notes on the arrest of hepatic haemorrhage due to trauma. *Ann Surg* 1908;48:541-9.
2. Streith L, Silverberg J, Kirkpatrick AW, et al. Optimal treatments for hepato-pancreato-biliary trauma in severely injured patients: a narrative review. *Can J Surg* 2020;63:E431-4.
3. Ordoñez CA, Parra MW, Salamea JC, et al. A comprehensive five-step surgical management approach to penetrating liver injuries that require complex repair. *J Trauma Acute Care Surg* 2013; 75:207-11.
4. Hester CA, Mokdad AE, Mansour JC, et al. Current pattern of use and impact of Pringle maneuver in liver resections in the United States. *J Surg Res* 2019;239:253-60.
5. Ball CG, Campbell A, Grondin SC, et al. Use of a novel saline/bipolar radiofrequency energy instrument as an adjunct for arresting ongoing solid organ surface and laceration bleeding in critically injured patients. *Injury* 2016;47:1996-9.
6. Yu L, Hongwei S, Jin H, et al. The effect of low central venous pressure on hepatic surgicla field bleeding and sérum lactate in patients undergoing partial hepatectomy: a prospective randomized controlled trial. *BMC Surg* 2020;20:25.
7. Navsaria PH, Nicol AJ, Krige JE, et al. Selective nonoperative management of liver gunshot injuries. *Ann Surg* 2009;249:653-6.
8. Kaibori M, Matsui K, Ishizaki M, et al. A prospective randomized controlled trial of hemostasis with a bipolar sealer during hepatic transection for liver resection. *Surgery* 2013;154:1046-52.
9. Sanjay P, Ong I, Bartlett A, et al. Meta-analysis of intermitente Pringle maneuver versus no Pringle maneuver in elective liver surgery. *ANZ J Surg* 2013;83:719-23.