Postoperative Intra-abdominal Pressure and Renal Function After Liver Transplantation

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Hypothesis: Intra-abdominal hypertension frequently threatens renal function early after orthotopic liver transplantation (OLT).

Design: A prospective study of consecutive patients who underwent OLT.

Setting: The intensive care unit of a National Health Service teaching hospital.

Patients and Main Outcome Measures: The intra-abdominal pressure (IAP) of 108 consecutive patients who underwent OLT was postoperatively measured 3 times a day for 72 hours using the urinary bladder technique. Intra-abdominal hypertension was defined as an IAP of 25 mm Hg or higher.

Results: Thirty-four patients (31%) had a high IAP. Acute renal failure developed in 17 recipients (16%), 11 (65%) of whom had intra-abdominal hypertension (P<.01), with a mean±SD IAP of 27.9±9.9 mm Hg vs 18.6±5.2 mm Hg in those without acute renal failure (P<.001). The subjects with a high IAP were more frequently administered loop diuretics to maintain adequate diuresis (P<.001) and had a low mean arterial pressure on the day of surgery (P<.01), despite the fact that they were given more intravenous fluids (P<.01) and did not differ in the need for inotropic drugs. Logistic regression analysis showed that intraoperative transfusions of more than 15 U, respiratory failure, and intra-abdominal hypertension (P<.01) were independent risk factors for renal failure. The length of intensive care unit stay was similar in the patients with a normal and a high IAP, but mortality was higher among the latter (P=.02).

Conclusions: Intra-abdominal hypertension is common after OLT and is significantly associated with renal failure, reduced urinary output, and intensive care unit mortality. It is, therefore, worth monitoring IAP in those undergoing OLT.

Arch Surg. 2003;138:703-706

Although the measurement of intra-abdominal pressure (IAP) is not new, its importance for critically ill patients is still under investigation. The association between renal impairment and increased IAP was first reported in 1876, but little attention was given to it and our understanding of the clinical significance of IAP remained poor until the second half of the past century, when numerous studies revealed the deleterious effects of high IAP on almost every organ and function within the abdominal cavity. Evidence of the clinical importance of intra-abdominal hypertension (IAH) has increased more recently, but, possibly because of some skepticism concerning its value, IAP is still not routinely measured in critically ill patients.

Subjects undergoing orthotopic liver transplantation (OLT) are at risk for IAH not only because of the pathophysiological features of the chronic liver disease (tense ascites) but also because of the particular characteristics of transplantation (intraabdominal hemorrhaging leading to the accumulation of blood and clots, the use of pericardiac or retroperitoneal packs to control nonsurgical bleeding, bowel edema or congestion due to portal hypertension or massive fluid resuscitation, and the use of pneumatic antishock garments). The renal function of patients undergoing OLT may be frequently threatened by an impending hepatoportal syndrome, problems of hydroelectrolytic homeostasis, or the frequent use of diuretics and nephrotoxic drugs; once renal failure is established, it severely affects patient outcome.

Given that, to the best of our knowledge, there is no published article concerning the relationship between IAH and renal function in subjects undergoing OLT. This study investigates the possible association between increased IAP and renal function impairment in the days immediately following OLT.
This prospective study involved a population of consecutive patients undergoing OLT at our center. The only exclusion criterion was perioperative renal dysfunction (defined as serum creatinine levels of 1.5 mg/dL [133 µmol/L] or greater as preoperative renal dysfunction or a creatinine level of 1.47 mg/dL [130 µmol/L] or an increase of more than 1.13 mg/dL [100 µmol/L] within 72 hours of surgery). Intra-abdominal hypertension and renal dysfunction were considered to be potentially related if they occurred within 48 hours of each other. Standard definitions were used for sepsis and respiratory and cardiovascular failure.

METHODS

The study population consisted of 108 consecutive patients (80 men and 28 women); their mean age was 53.7 years (25th-75th percentile, 45-58 years). Eighty-eight patients (81%) underwent transplantation for liver cirrhosis due to viral infection, 6 (6%) due to alcoholic cirrhosis, and 14 (13%) due to other causes. Other relevant data about the study population are shown in Table 1.

The IAP in the population as a whole was 21.5±8.2 mm Hg (range, 9.5-57 mm Hg). Thirty-four subjects had a persistently high IAP (group H), whereas it was always lower or only occasionally higher than 25 mm Hg in the remaining 74 subjects (group N).

Renal function was evaluated by measuring daily urinary output per hour and, on the second and fourth postoperative days, serum creatinine levels. Acute renal failure (ARF) was defined as a postoperative serum creatinine concentration of more than 1.47 mg/dL (>130 µmol/L) or an increase of more than 1.13 mg/dL (>100 µmol/L) within 72 hours of surgery. Intra-abdominal hypertension and renal dysfunction were considered to be potentially related if they occurred within 48 hours of each other. Standard definitions were used to evaluate the effect of predetermined risk factors on renal function. Statistical significance was set at P=0.05.

RESULTS

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The abdominal cavity can be considered a single compartment, so any change in its content increases the atmospheric or even negative IAP found in normally breathing subjects; consequently, an increase in the volume of abdominal or retroperitoneal content can lead to an increase in IAP that, at the bedside, is best measured via a urinary bladder catheter connected to a pressure transducer. However, the pathophysiological mechanism underlying this injury is still unclear, although, since the first demonstration that effective renal plasma blood flow and the glomerular filtration rate are reduced by IAH, there have been claims that many factors may be implicated. Recent reports tend to consider the cause of renal impairment in patients with IAH as multifactorial. Diminished renal arterial blood flow (due to decreased cardiac output), the shunting of blood from the cortex into the medulla, direct compression of kidney and renal veins, high renal venous pressure, and high levels of antidiuretic hormone, renin, and aldosterone have been advocated as possible cofactors, whereas ureteral occlusion and consequent postrenal azotemia have been excluded as major causal factors because the placement of ureteral stents did not improve renal function in subjects with IAH.

We decided to set our threshold for IAH at the highest value reported in the literature to highlight the pathophysiological relationship between IAH and ARF in a short-term situation such as the post-OLT period. However, when the threshold is set at lower levels (as in the studies by Sugrue et al), IAH is more frequent (40.7% vs 31% in our study), but the incidence of renal dysfunction remains similar (32.7% vs 32% in our study). This suggests that factors other than absolute IAP levels should be considered in the pathogenesis of the renal dysfunction occurring in postsurgical patients with IAH. Our experience seems to indicate not only that renal impairment is dose dependent (ARF significantly increases with the increase in IAH) but also that the duration of IAH may play an important role in this setting; ARF was more frequent in group H patients, who had IAH for at least 12 consecutive hours, than in those in group N, whose mean IAP was normal (but higher than in previous studies) or only occasionally higher than 25 mm Hg.

Other factors could influence renal function in the presence of a high IAP (eg, a low level of intravascular filling can play a major role in increasing the risk of ARF in patients with IAH). Loading patients with intravenous fluids may prevent the deleterious effects of IAH by counteracting the reduced cardiac output due to the diminished preload, caused by the fact that venous return to the heart is hampered by IAH-induced compression of the inferior and superior vena cava compartment (because of increased abdominal and thoracic pressures). However, our experience indicates that, although this approach can successfully maintain a stable hemodynamic state, it does not prevent renal failure because, despite that our patients with IAH received significantly more fluids than the normotensive subjects and their hemodynamic data were never critical in terms of systemic and renal perfusion, they were more frequently affected by ARF. This may have been
due to the action of local factors, such as the shunting of blood from the cortex to the medulla, the direct compression of kidney and renal veins, or high renal venous pressure, that play a major role in causing ARF in the presence of IAH. 3,7,15,18 However, fluid therapy was helpful in containing the severity of ARF, as is shown by the slight, although significant, increase in serum creatinine levels in the group H patients.

This observation also explains why we decided to adopt a conservative attitude toward the patients with IAH. Abdominal decompression by repeated laparotomy is an appealing way of reducing the risks associated with IAH, but although there have been reports of the prompt reversal of ARF after decompression, they are few 20 and even controversial; furthermore, although decompressive celiotomy can lead to a significant reduction in IAP and better dynamic pulmonary compliance, it does not improve renal function or patient oxygenation. 3 Nonclosure of the abdominal closure: a prospective evaluation of its effects on renal and respiratory function. Arch Intern Med. 1979;139:175–180.


