

Long-Term Effect of Jejunoileal Autotransplantation on Motility and Transit Time in Canine Small Bowel

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SMALL bowel transplantation (SBT) has become clinically feasible. The surgical procedure including transection, denervation, and ischemia may alter intestinal motility. A study of motility in the transplanted small bowel may help increase the understanding of clinical problems, such as diarrhea, which are frequently seen after SBT. The purpose of this study was to determine the effect of SBT on fasted intestinal motility and small intestinal transit in dogs.

MATERIALS AND METHODS

Adult mongrel dogs of either sex weighing 18 to 25 kg were used. The entire small intestine was procured, flushed, and then immediately reimplanted into the same dog. Intestinal continuity was restored by end-to-end anastomosis of the jejunum and ileum, using Gambee's technique. Multiple strain gauge transducers (SGT) were implanted in autotransplanted (AT) dogs at the host gastric antrum (1), pylorus (1), duodenum (1), graft jejunum (2), ileum (2), and the host ileum. SGTs were implanted at similar sites in sham dogs.

Motility Recordings

Motility was recorded in four groups of dogs implanted with SGTs: group I, sham control ($n = 4$), and in three groups of AT dogs: group II, 0 to 3 months posttransplant ($n = 5$); group III, 6 months posttransplant ($n = 6$); and group IV, 12 months posttransplant ($n = 6$). Motility was recorded on postoperative days (POD) 1, 3, 7, 14, 21, and 28 in groups I and II; and then at 2-week intervals over a 3-month period for group III. Animals were fasted for 18 hours before each measurement. Motility was recorded for 8 to 12 hours. Spontaneous, strong, repetitive phasic contractions lasting longer than 4 minutes, which propagated aborally, were defined as phase 3 of the migrating motor complex (MMC). Characteristics of phase 3 were analyzed visually. Results were expressed as mean \pm SEM.

Barium Meal Study

Small intestinal transit time (SITT) was measured in a separate group of dogs: group 1, control dogs ($n = 9$), and in four groups of AT dogs: group 2, 1 month posttransplant ($n = 10$); group 3, 3 months posttransplant ($n = 5$); group 4, 6 months posttransplant ($n = 9$); and group 5, 12 months posttransplant ($n = 7$). To determine fed intestinal transit, barium sulfate was mixed with liquid meal (200 mL, 840 kJ; Ensure). Barium concentration was diluted at 10% w/vol to perform the experiments physiologically. Test meal was gently introduced into the stomach through an orogastric tube. Gastroduodenal transit time was determined under fluoroscopy as the first emptying of the stomach. Roentgenogram was obtained every 15 minutes for 2 hours and at 30-minute intervals thereafter. Gastrocecal transit time was determined as the first filling of the cecum. SITT was determined as the

time difference between gastroduodenal transit time and gastrocecal transit time.

RESULTS

Phase 3 contractions were observed in all sham dogs (four of four) in both the jejunum and ileum on POD 1. Phase 3 contractions were also observed in AT dogs on POD 1. However, the incidence of phase 3 contractions (number per hour) on POD 1 was significantly ($P < .05$) lower in AT dogs (0.16 ± 0.05) compared with sham dogs (0.71 ± 0.25). The incidence of phase 3 in AT dogs increased thereafter (POD 1 = 0.16 ± 0.05 , POD 3 = 0.53 ± 0.16 , POD 7 = $0.75 \pm 0.06^*$, and POD 14 = $0.81^* \pm 1.10$; $*P < .05$ vs POD 1). Coordination of phase 3 between host duodenum and graft jejunum was (>90%) recovered 1 month following SBT. Propagation velocity and duration of phase 3 in the small bowel were significantly ($P < .05$) slowed or prolonged in AT dogs, which recovered by 6 to 12 months following SBT. The frequency of contractions during phase 3 significantly decreased from proximal to distal intestine in sham dogs (18.7 ± 0.40 vs 17.5 ± 0.25 vs 16.7 ± 0.14 vs 14.3 ± 0.09 vs 13.6 ± 0.11 in duodenum > proximal jejunum > distal jejunum > proximal ileum > distal ileum; $P < .05$). The gradient in the frequency during phase 3 between proximal and distal segments disappeared within the transplanted bowel. SITT was markedly shortened in AT dogs compared with control dogs at all time intervals following SBT (control = 133 ± 14 , 1 month = $29 \pm 7^*$, 3 months = $30 \pm 4^*$, 6 months = $27 \pm 5^*$, 12 months = $79 \pm 15^*$; $*P < .001$ vs control). This accelerated intestinal transit was partially recovered at 12 months ($P < .01$ vs AT dogs 1, 3, and 6 months).

DISCUSSION

A true AT model of canine jejunoileum was used to avoid the influences of rejection and immunosuppression on intestinal motility. Previous studies showed that the initi-

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ation of phase 3 was severely delayed following SBT.^{1,2} In contrast to these reports, the transplanted bowel was able to initiate and propagate phase 3 even on POD 1 in our study. Our results indicate that the mechanism of initiating and propagating phase 3 in the intestinal graft is not impaired by the surgical procedures accompanying SBT.

Disruption of intestinal continuity causes discoordination of phase 3 between the proximal and distal segments. Disrupted motility between the segments often recovers within 2 to 4 months when restored by end-to-end anastomosis after mere transection or even after a modified experimental AT model (transection plus denervation).³ However, true AT impaired the coordination between the host and graft intestine for 2 years after SBT.⁴ However, our results clearly demonstrate that the coordination of phase 3 improved greatly 1 month following SBT. Thus, the mechanism involving coordination of phase 3 between the host and graft intestine is not permanently impaired by the SBT surgical procedure. Furthermore, the coordination of phase 3 recovered very early compared with previous studies using Gambee's anastomotic technique.

Our results demonstrate that SITT is markedly shortened following SBT. The accelerated intestinal transit could enhance the impairment of absorption of water, electrolytes, and nutrients caused by denervation of the small bowel. This shortened SITT may also play an important role in the development of diarrhea following SBT.

The present study shows that fasting intestinal motility following SBT was not severely impaired despite possible neuromuscular damage due to transection, denervation, and ischemia, and that most motility changes caused by SBT are recovered by 1 year. However, in fed states, accelerated SITT persisted during the entire study period.

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