Intolerance to enteral feeding in the brain-injured patient

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Calorie and protein supplementation improves nutritional status. This support may improve outcome and decrease morbidity and mortality in acutely brain-injured patients. Investigators have observed a poor tolerance to enteral feedings after brain injury and have noted that this persists for approximately 14 days postinjury. This delay has been attributed to increased gastric residuals, prolonged paralytic ileus, abdominal distention, aspiration pneumonitis, and diarrhea.

In the present investigation, 23 brain-injured patients with an admission 24-hour peak Glasgow Coma Scale (GCS) score between 4 and 10 were studied for 18 days from hospital admission. The mean duration from injury to initiation of full-strength, full-rate enteral feeding was 11.5 days. Seven of the 23 patients tolerated enteral feedings within the first 7 days following hospital admission (mean 4.3 days), four patients tolerated feedings between 7 and 10 days postadmission (mean 9 days), and 12 patients did not tolerate feedings until after 10 days postinjury (mean 15.9 days). There was a marginally significant relationship between low GCS scores on admission and length of days to enteral feeding tolerance (p = 0.07). A significant inverse relationship was observed between daily peak intracranial pressure (ICP) and time to tolerance of feedings (p = 0.02). There was no significant relationship between feeding tolerance and days to return of bowel sounds (p = 0.12).

Serum albumin levels decreased during the investigation (mean ± standard error to the mean: 3.2 ± 0.12 gm/dl on Day 1; 2.7 ± 0.23 gm/dl on Day 16; normal = 3.5 to 5.0 gm/dl), whereas the percentage of patients tolerating feedings increased over the course of the study. The authors conclude that patients with acute severe brain injury do not adequately tolerate feedings via the enteral route in the early postinjury period. Tolerance of enteral feeding is inversely related to increased ICP and severity of brain injury. It is suggested that parenteral nutritional support is required following brain injury until enteral nutrition can be tolerated.

KEY WORDS: enteral feeding - nutritional support - head injury

Clinical Material and Methods

Patient Population

Twenty-eight consecutive brain-injured patients who had an admission 24-hour peak Glasgow Coma Scale (GCS) score between 4 and 10 were studied from hospital admission through Day 18 postinjury (Table 1). There were six women and 22 men ranging in age from 18 to 74 years (mean age 27 years). The mean peak 24-hour GSC score on admission was 6.6. In all cases the primary injury was to the brain.

Enteral Feeding Regimen

Salem sumps* were inserted orally or nasogastrically in the emergency room and adjusted to low wall suction to prevent regurgitation of stomach contents (Fig. 1). Daily gastric residual volumes were measured and recorded every 2 hours thereafter. Auscultation was performed every 4 hours to determine when bowel sounds were present. Abdominal distention was defined by

* Sump manufactured by Argyle, Division of Sherwood Medical, St. Louis, Missouri.
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TABLE 1
Summary of clinical data for the 23 cases in this series*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)</th>
<th>Peak GCS</th>
<th>Type of Injury</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20, M</td>
<td>9</td>
<td>CHI</td>
<td>MD</td>
</tr>
<tr>
<td>2</td>
<td>24, M</td>
<td>6</td>
<td>lt subdural/intracerebral hemorrhoma</td>
<td>MD</td>
</tr>
<tr>
<td>3</td>
<td>74, F</td>
<td>10</td>
<td>intracerebral hematoma</td>
<td>SD</td>
</tr>
<tr>
<td>4</td>
<td>51, M</td>
<td>8</td>
<td>CHI</td>
<td>SD</td>
</tr>
<tr>
<td>5</td>
<td>24, F</td>
<td>6</td>
<td>CHI</td>
<td>SD</td>
</tr>
<tr>
<td>6</td>
<td>20, M</td>
<td>7</td>
<td>gunshot wound</td>
<td>GR</td>
</tr>
<tr>
<td>7</td>
<td>23, M</td>
<td>8</td>
<td>CHI, lt rib fx &amp; clavicle fx, lt hemotorax</td>
<td>GR</td>
</tr>
<tr>
<td>8</td>
<td>23, M</td>
<td>7</td>
<td>CHI, facial fx</td>
<td>SD</td>
</tr>
<tr>
<td>9</td>
<td>27, M</td>
<td>7</td>
<td>CHI</td>
<td>GR</td>
</tr>
<tr>
<td>10</td>
<td>26, M</td>
<td>5</td>
<td>CHI, lt pneumothorax with rt rib fx</td>
<td>VS</td>
</tr>
<tr>
<td>11</td>
<td>66, F</td>
<td>7</td>
<td>CHI, basilar skull fx, clavicle &amp; rib fx, rt pubic ramus &amp; rt femur fx</td>
<td>VS</td>
</tr>
<tr>
<td>12</td>
<td>36, M</td>
<td>7</td>
<td>CHI</td>
<td>VS</td>
</tr>
<tr>
<td>13</td>
<td>27, M</td>
<td>9</td>
<td>gunshot wound</td>
<td>VS</td>
</tr>
<tr>
<td>14</td>
<td>22, M</td>
<td>5</td>
<td>CHI, facial fx, lt clavicle fx, cervical spine fx</td>
<td>SD</td>
</tr>
<tr>
<td>15</td>
<td>46, M</td>
<td>6</td>
<td>subdural/epidural hematoma</td>
<td>VS</td>
</tr>
<tr>
<td>16</td>
<td>27, F</td>
<td>6</td>
<td>gunshot wound</td>
<td>VS</td>
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<tr>
<td>17</td>
<td>29, M</td>
<td>8</td>
<td>CHI with basilar skull fx, facial fx</td>
<td>SD</td>
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<tr>
<td>18</td>
<td>41, M</td>
<td>4</td>
<td>severe brain laceration due to depressed skull fx, multiple rib fx, hemotorax</td>
<td>VS</td>
</tr>
<tr>
<td>19</td>
<td>23, M</td>
<td>5</td>
<td>gunshot wound</td>
<td>VS</td>
</tr>
<tr>
<td>20</td>
<td>28, M</td>
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<td>lt subdural hematoma, rt epidural hematoma, diffuse intracerebral hemorrhage</td>
<td>VS</td>
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<tr>
<td>21</td>
<td>24, M</td>
<td>4</td>
<td>CHI with basilar skull fx &amp; rt intracerebral hematoma</td>
<td>VS</td>
</tr>
<tr>
<td>22</td>
<td>21, M</td>
<td>6</td>
<td>CHI, rt femur fx, rt pubic ramus fx, facial fx, cervical spine fx, sacral fx</td>
<td>SD</td>
</tr>
<tr>
<td>23</td>
<td>19, M</td>
<td>8</td>
<td>CHI, rib fx, rt pneumothorax</td>
<td>VS</td>
</tr>
</tbody>
</table>

* GCS = Glasgow Coma Scale score; CHI = closed head injury; fx = fracture.
† Outcome was determined on Day 18. GR = good recovery; MD = moderate disability; SD = severe disability; VS = vegetative state.

observation and palpation. If gastric residual volumes were less than 200 cc/day and bowel sounds were present, enteral feedings were initiated via the Salem sump. Patients were given either TraumaCal or Ensure Plus.† These formulas are similar except that TraumaCal is composed of 83 gm protein/liter whereas Ensure Plus contains 55 gm protein/liter. No intolerance could be attributed to the difference in feeding formula.

Feedings were started at 25 ml/hr at one-quarter strength using a Kangaroo pump.‡ The feeding formulas were colored with green food coloring (0.1 ml/liter) to detect aspiration of stomach contents through the feeding tube. The head of the bed was elevated a minimum of 30°. If gastric residuals were less than 100 cc every 2 hours and there was no abdominal distention, diarrhea, aspiration, or regurgitation, then the formula concentration was increased every 6 hours by one-quarter strength increments until full-rate feedings were achieved. When the patients tolerated full-strength tube feeding, the Salem sump was removed and a small-bore feeding tube (either Duotube or Keofeed§) was inserted. Metoclopramide, 10 to 20 mg every 6 hours, was administered intravenously and the patients were positioned on their right side to facilitate passage of the transpyloric feeding tube.‡ Abdominal x-ray films were obtained 24 to 48 hours after insertion of the feeding tube to confirm gastric or duodenal placement of the tube tip. The feeding rate was increased by 25-cc increments every 6 hours until the calculated energy and protein requirements were achieved. Feedings were administered continuously over 24 hours.‡ If the feeding tube was displaced during critical care management, a new tube was inserted; if displacement recurred, a

‡ TraumaCal supplied by Meade Johnson, Evansville, Indiana; Ensure Plus supplied by Ross Laboratories, Columbus, Ohio.
‡ Kangaroo pump manufactured by Cheseborough-Ponds, Watertown, New York.
§ Duotube manufactured by Argyle, Division of Sherwood Medical, St. Louis, Missouri; Keofeed manufactured by Ivac Corp., San Diego, California.
Albumin Analysis

Albumin concentrations were measured photometrically with a Hitachi instrument.*

Statistical Analysis

Variables analyzed included the admission GCS score, peak ICP, duration of ICP monitoring, time interval from admission until bowel sounds returned, and serum albumin levels. Patients were considered to be in one of three groups according to the length of time before full-strength, full-rate feedings were achieved: that is, those who tolerated feeding within the first 7 days, between 7 and 10 days, or more than 10 days after injury. A one-way analysis of variance was used to compare means of these three groups. Standard errors of the mean were based on the error mean square. Patients with and without aspiration were compared by t-test for continuous data and Fisher’s exact test for categorical data.

Results

Of the original 28 patients, three died before the end of the 18-day study period and two had abdominal injuries that required exploratory laparotomy. These five patients were not included in this analysis. Seven (30%) had extracranial injuries including rib fractures, long-bone fractures, or pneumothoraces. Four patients had sustained gunshot wounds, one had a depressed skull fracture with brain contusion, 14 had closed head injuries, and the remaining four sustained hematomas. The mean duration from injury to initiation of full-strength, full-rate feeding was 11.5 days. Seven of the 23 patients tolerated enteral feedings within the first 7 days following hospital admission (mean 4.3 days), four patients tolerated feedings 7 to 10 days after admission (mean 9 days), and 12 patients did not tolerate full-strength, full-rate feedings until more than 10 days postinjury (mean 15.9 days). There was a marginally significant relationship between a low GCS score on admission and number of days to enteral feeding tolerance (Fig. 2 left) (p = 0.07). A significant relationship was noted between the number of days that ICP monitoring was necessary and time to tolerance of full-strength, full-rate feedings (Fig. 2 right) (p = 0.02). A significant inverse relationship was observed between daily peak ICP and number of days to tolerance of enteral feedings (Fig. 3 left) (p = 0.02). The relationship between the length of time to feeding tolerance and the number of days to return of bowel sounds was not significant (Fig. 3 right) (p = 0.12). There was a significant relationship between the occurrence of aspiration pneumonitis and the number of days to tolerance of enteral feeding (mean 2.4 ± 0.68 and 6.1 ± 0.74 days for patients with and without aspiration, respectively;
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p = 0.02). All five patients (27.8%) in whom aspiration occurred underwent ICP monitoring while none of the five patients who did not have ICP monitored suffered aspiration. Serum albumin levels decreased during the investigation (mean 3.2 ± 0.12 gm/dl on Day 1; 2.7 ± 0.23 gm/dl on Day 16; normal = 3.5 to 5.0 gm/dl), whereas the percentage of patients tolerating full-strength, full-rate feedings increased over the course of the study (Fig. 4).

Aspiration pneumonitis was a complication in five (22%) of the 23 patients. Diarrhea was observed in 17 patients (74%) and pseudomembranous colitis occurred in two (9%). Sixteen patients (70%) had gastric residual volumes of more than 100 cc over a 2-hour period for at least 1 day during the study period. Nasoduodenal tube placement was successful in only 10% of patients, and 50% of these tubes were quickly dislodged during critical care therapy.

Discussion

This study revealed significant relationships between the time to tolerance of full-strength, full-rate enteral feedings, increased ICP, period of ICP monitoring, and low admission GCS score. The mechanisms of this relative intolerance may be multifactorial. Central nervous system (CNS) modification of gastrointestinal function is well established. Neural reflexes that arise from the stomach act through autonomic motor nerves to allow regulation of gastric motility by the CNS. Neural reflexes initiated by distention of the stomach wall, active gastric contractions, and activation of chemoreceptors by gastric contents regulate gastric motility and emptying.

It is probable that ablation or damage of higher centers in the CNS will influence the effects of the CNS on the gut. After truncal vagotomy, normal postprandial motor activity is curtailed in dogs and man. Garrick, et al., found that gastric motility was inhibited by increased intracerebroventricular pressure in rabbits. In that study, increased ventricular pressure resulted in immediate suppression of gastric motility by greater than 80%. Bolus injection of bethanecol reversed this suppression for a mean time of only 7.3 ± 0.6 minutes. Thirty minutes following normalization of ventricular pressure, gastric motility returned to basal levels. These investigators concluded that increased ICP rapidly suppressed gastric motility in conscious rabbits. Our data suggest that this may also be true during the first 14 days after head trauma in humans.

Andrassay has suggested that hypoalbuminemia is another mechanism for intolerance of enteral feeding in brain-injured patients. Albumin maintains oncotic pressure in the gastrointestinal tract, and hypoalbuminemia is observed in these patients. Albumin levels reach a nadir 2 weeks postinjury, whereas enteral feeding tolerance occurs approximately 11 days following brain injury. Thus, there appears to be a disassociation between hypoalbuminemia and enteral feeding tolerance, with feeding tolerance developing when the serum albumin concentration is at its nadir.

Both enteral and parenteral feeding routes can provide adequate nutrition for critically injured patients, but enteral feeding is preferred because it is a more physiologically natural feeding mode. However, 22% of comatose patients receiving tube feeding in this study developed aspiration pneumonitis due to regurgitation of formula. Possible mechanisms to account for this high incidence of aspiration pneumonitis include a depressed or absent gag reflex and/or cough reflex or gastrointestinal motility disorders. No aspiration occurred in the patients who did not undergo ICP monitoring.

Kiver, et al., studied patients receiving pre- or postpyloric enteral feedings and found that the incidence of aspiration pneumonitis was 46% in the prepyloric.
group and 6% in the postpyloric group (p = 0.005). In a study of 720 neurological patients, Olivares, et al., 12 showed that 9.9% of the patients had evidence of aspiration pneumonitis on autopsy examination, and 5% of their head-injured patients had evidence of this condition. They found a significant correlation between the use of a nasogastric tube and the postmortem finding of aspiration, and concluded that gastric tube feeding increased the risk of aspiration six times. They believed this complication was exacerbated by the loss of the cough reflex and retrograde emptying of the stomach.

Incompetence of the lower esophageal sphincter in brain-injured patients also appears to contribute to the risk for aspiration pneumonitis. An inverse relationship between increased ICP and lower esophageal sphincter tone has been demonstrated by Vane and coworkers. 19 Kahrilas, et al., 8 demonstrated that sleep alone significantly decreased upper esophageal sphincter pressure in normal subjects.

We found that transpyloric placement of feeding tubes was difficult to achieve. When transpyloric placement was spontaneously achieved, the tube was often dislodged during critical care therapy. Rombeau and coworkers 15 have developed a double-lumen feeding tube that decompresses the stomach while feedings are administered into the jejunum. This tube may allow earlier tolerance of enteral feeding in the brain-injured patient; however, it requires a gastrojejunosotmy. 15

In summary, acutely brain-injured patients do not adequately tolerate feedings via the enteral route in the early postinjury period. Adequate calorie and protein supplementation could not be achieved via the nasogastric route for a mean time of 11.5 days. The rate of aspiration pneumonitis was 22% during enteral feeding. Feeding intolerance was significantly related to aspiration pneumonitis on autopsy examination, and 9.9% of the patients had evidence of this condition. They found a significant correlation between the use of a nasogastric tube and the postmortem finding of aspiration, and concluded that gastric tube feeding increased the risk of aspiration six times. They believed this complication was exacerbated by the loss of the cough reflex and retrograde emptying of the stomach.

References


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