

## ASSESSMENT OF SERUM VITAMIN B12 CONCENTRATIONS IN PATIENTS WITH A COMPOSITE GASTROINTESTINAL URINARY RESERVOIR (CHARLESTON POUCH II)

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**Objectives** Long-term metabolic neutrality of gastrointestinal pouches used for urinary diversion has been demonstrated in a multi-institutional study. A theoretical concern exists that loss of substantial portions of the stomach and intestine with reduction in the secretion of intrinsic factor, and the loss of part of the intestinal absorptive surface may impair vitamin B12 absorption. In an attempt to evaluate these concerns in the clinical setting, we studied the intermediate-term effect of a gastrointestinal continent urinary diversion on serum levels of vitamin B12 concentrations.

**Patients and Methods** Sixteen patients (8 women and 8 men aged 28-72 years) who had gastrointestinal pouches were studied. The 16 patients included 10 who had pelvic malignancy, 3 of whom had large radiation induced vesicovaginal or vesicovaginal and vesicointestinal fistula. Seven patients were converted from ileal conduit. Serum vitamin B12 levels were obtained preoperatively and every 6 months postoperatively. All patients received 100 microgram of vitamin B-

12 twice yearly. Follow up ranged from 3-10 years.

**Results** All 16 patients included in the study had a normal concentration of serum vitamin B12 preoperatively with a range of 282-600 pg/ml (mean 430 pg/ml). All patients maintained normal serum vitamin B12 concentrations during the study period, which ranged from 36-120 months. At 6 months, serum vitamin B12 concentrations were 280-586 pg/ml (mean 433 pg/ml). At 1, 2, 3, 4, 5, 7, 9, 10 years the mean vitamin B12 levels were: 838,445,764, 695,881, 390, 405,400 pg/ml respectively.

**Conclusion** This limited study in which a modest supplement of vitamin B12 (100 micrograms twice yearly) was given, demonstrated no detrimental effect on vitamin B12 concentrations for up to 10 years following construction of a gastrointestinal urinary reservoir.

**Key Words** urinary diversion, gastrointestinal pouches, composite reservoirs, vitamin B12, cobalamine

### INTRODUCTION

Established techniques for continent urinary diversion, to the skin or orthotopic, are not ideal for patients who have had extensive pelvic radiation, short bowel syndrome or metabolic acidosis<sup>1,2</sup>. In 1956 Sinaiko constructed an artificial bladder using a gastric pouch in dogs and then in humans to avoid the long-term potential metabolic absorption problems where urine is in contact with colonic mucosa and to a lesser extent with ileal mucosa<sup>3,4</sup>. In 1977, Rudick et al. used vagally denervated gastric fundus as a urinary reservoir<sup>5</sup>. Lockhart et al. reported a concept of combining gastric

and intestinal segments as a composite urinary reservoir in order to temporize the metabolic complications associated with pure intestinal or gastric reservoirs<sup>1</sup>. Long-term metabolic neutrality of gastrointestinal pouches has been demonstrated in single and multi-institutional studies<sup>1,2</sup>. A theoretical concern is that the loss of substantial portions of the stomach and intestine may impair vitamin B12 absorption by decreasing the secretion of intrinsic factor combined with the loss of part of intestinal absorptive surface.

In an attempt to evaluate these concerns in the clinical setting, we studied the intermedi-

ate-term effects of gastrointestinal continent urinary diversion on serum vitamin B12 concentration.

## PATIENTS AND METHODS

Sixteen patients with gastrointestinal reservoirs (8 women and 8 men) aged between 28 and 72 years (mean 54 years) were studied. Of the 16 patients 10 had pelvic malignancy; 3 of these had large radiation-induced vesicovaginal or vesicovaginal and vesicointestinal fistulae. Seven patients were converted to gastroileal pouch from an ileal conduit.

The gastrointestinal reservoirs were constructed from a triangular gastric segment based on the greater curvature of the stomach and a 10-cm transverse colon segment or 15-cm ileal segment. A 5-cm gastric strip in continuity with the triangular gastric segment was tubularized and imbricated to form the outlet. In five patients with ileal conduit, the stoma was taken down and the conduit was detubularized and incorporated with the gastric patch to form the urinary reservoir.

Serum vitamin B12 concentrations were obtained preoperatively. All patients received a modest dose of intra muscular vitamin B12 (100 micrograms every 6 months). The follow-up ranged from 36 -120 months. Serum vitamin B12 concentrations were obtained every 6 months. Because of the early observation that high levels of vitamin B12 were measured after intra muscular injections of the vitamin, these samples were excluded and subsequent measures were obtained before injection.

## RESULTS

All 16 patients included in the study had A normal concentration of serum vitamin B12 preoperatively, with a range of 282-600 pg/ml (mean 420 pg/ml). The normal reference range in our lab is 247-1000 pg/ml. All patients maintained normal serum vitamin B12 concentrations during the study period which ranged from 36-120 months. At 6 months, serum vitamin B12 concentrations were 280-586 pg/ml (mean 433 pg/ml). At 12 months, the mean vitamin B12 concentrations were 838 pg/ml (range 350-1000). At 2 years, the mean was 445 pg/ml (range 290-1200). At 3 years, the range was 282-1246 pg/ml (mean 764pg/ml). At 4, 5, 7, 9, 10 years the mean vitamin B12

levels were: 695,881,390, 405,400 pg/ml respectively.

## DISCUSSION

Sinaiko et al. postulated several theoretical advantages for using a gastric pouch for urinary diversion. The stomach mucosa is less absorbing, there is no loss of electrolytes, gastric secretions protect against urinary tract infections and proximal ureters could be used for ureterogastric anastomosis. The gastric mucosa washed with urine maintains its acid secretory activity with clear net chloride flux into the urine. There is minimal water loss but significant hydrogen chloride and sodium flux into the urine potentially resulting in hypochloremic, hyponatremic, hypokalemic alkalosis. On the other hand, large and small bowel have absorptive mucosa which results in net flux of hydrogen and chloride ions and ammonia from urine back to serum with tendency to hyperchloremic acidosis<sup>6</sup>. The dynamics of the stomach seem to be favorable for the construction of a reservoir. Although it takes more time than small or large bowel to distend (6-8 months), in most patients the gastric reservoirs eventually expand far beyond the size of its original volume. The gastric reservoir tends to empty well with minimal residual volumes<sup>7</sup>. The acid content and the gastric lysozymes, which inhibit bacterial growth, help maintain relatively sterile urine. The unique gastroepiploic pedicle of the gastric segment makes it very mobile and thus easy to construct a reservoir deep in the pelvis, and the rich blood supply facilitates the construction of gastric tubes and reservoir simultaneously. Continent urinary diversion utilizing pouches constructed entirely from the stomach has several undesirable effects<sup>8</sup>. Pain may occur secondary to acid production from the gastric flap. Haematuria occurs in 36% of gastric augmentation patients. Haematuria associated with bladder spasm or dysuria, the haematuria-dysuria syndrome, is also well documented. Metabolic alkalosis may be evident in patients with short bowel syndrome due to salt losing nephropathy, vomiting or diarrhea<sup>9</sup>.

Several authors have studied vitamin B12 after urinary diversion utilizing intestinal segments with different conclusions.<sup>10-14</sup> Van Ophoven et al.<sup>11</sup> reported on 16 patients who had no initial vitamin B12 supplements after ileocaecal<sup>10</sup> or ileal<sup>6</sup> substitution enterocystoplasty and who were followed for 15-117

months (mean 57 months). Sagalowsky and Frankel<sup>11</sup> evaluated 41 patients for evidence of vitamin B12 deficiency 0-10 years after urinary diversion by ileal reservoir, ileocaecal reservoir or ileal conduit. They noted a 14%, 10% and 0% vitamin B12 deficiency in patients with ileal neobladders/ileal reservoirs, ileocaecal reservoirs and ileal conduit, respectively. Finally, Yakout and Bissada<sup>13</sup> reported no critical adverse effect on serum vitamin B12 concentrations in 58 patients who received modest vitamin B12 supplements for 3-11 years after ileocaecal continent urinary diversion. Based on all these studies, it is reasonable to conclude that the adverse effects of urinary diversion is related to the site and length of the intestinal segment utilized and that in most situations the effect is modest and easily managed with small doses of vitamin B12.

To our knowledge, this is the first study to address vitamin B12 concentrations after construction of gastrointestinal urinary reservoirs. Two factors are essential for vitamin B12 absorption: the gastric intrinsic factor and the absorptive surface of the ileum. The intrinsic factor is produced by the parietal cells of the stomach and complexes with vitamin B12. The complex is then absorbed in the distal ileum<sup>14</sup>. Partial gastrectomy done for duodenal or gastric ulcers or for carcinoma of the upper portion of the stomach was associated with lowered vitamin B12 serum levels and hypergastrinemia. A large number of these patients showed manifest neurologic complications as myelopathy and polyneuropathy<sup>16,17</sup>. Another study showed that low serum vitamin B12 in the elderly is usually a consequence of disease rather than of old age per se and that gastric mucosal atrophy plays a major aetiologic role<sup>18</sup>. For various reasons including age differences as well as the gastric segment removed or excluded for construction of the composite reservoir, patients undergoing composite gastrointestinal urinary reservoirs may have different risk potentials for the development of vitamin B12 deficiency than those who had partial gastrectomy for peptic ulcer disease or gastric carcinoma. However, as stated previously, the effects of construction of gastric or composite gastrointestinal urinary reservoirs has not been studied previously. It is reassuring that the current limited study demonstrates that construction of a composite gastrointestinal urinary pouch in patients with normal pre-operative vitamin B12 levels did not result in significant reduction in serum vitamin B12 levels during 3-10 years of follow up. Whether the modest vi-

itamin B12 replacement (100 microgram injections every 6 months) has contributed to these findings is speculative.

In conclusion, a gastrointestinal urinary reservoir is desirable in patients with previous pelvic irradiation, short bowel syndrome or metabolic acidosis. The current limited study, in which a minimal supplement of vitamin B12 (100 micrograms twice yearly) was given, demonstrated no detrimental effects on vitamin B12 concentrations during the first decade after construction of the gastrointestinal urinary reservoir.

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## RESUME

### Évaluation des concentrations sériques en Vitamine B12 chez les patients avec un réservoir urinaire composite gastro-intestinal (Poche de Charleston II)

**Objectifs** La neutralité métabolique à long terme des poches gastro-intestinales utilisées pour la dérivation urinaire a été démontrée dans une étude multi-centrique. Un souci théorique existe de que la perte substantielle d'une partie de l'estomac et de l'intestin avec la réduction de la sécrétion du facteur intrinsèque et la perte d'une partie de la surface intestinale peut altérer l'absorption de la vitamine B12. Afin d'essayer d'évaluer ces soucis dans le cadre clinique, nous avons étudié l'effet à moyen terme d'une dérivation urinaire continente gastro-intestinale sur les concentrations en vitamine B12 au niveau du sérum. **Patients et Méthodes** Seize patients (8 femmes et 8 hommes âgés de 28-72 années) qui ont eu des poches gastro-intestinales ont été étudiés. Des 16 patients, 10 avaient une néoplasie pelvienne dont 3 avaient une importante irradiation avec fistule vesicovaginale ou fistule vesicovaginale et vesicointestinale. Sept malades ont eu une conversion d'une dérivation trans iléale. Des dosages sériques préopératoires et chaque 6 mois en postopératoire de vitamine B12 ont été demandés. Tous les malades ont reçu 100 microgram de vitamine B12 deux fois annuellement avec un suivi de 3-10 ans. **Résultats** Les 16 patients inclus dans l'étude avaient des concentrations sériques normales en vitamine B12 en préopératoire avec un taux de 282-600 pg/ml (moyenne 430 pg/ml). Tous les malades ont maintenu un taux sérique de vitamine B12 normal pendant la période de l'étude qui était de 36-120 mois. À 6 mois, les concentrations sériques en vitamine B12 étaient de 280-586 pg/ml (moyenne = 433 pg/ml). À 1, 2, 3, 4, 5, 7, 9, 10 ans les niveaux sériques moyens de vitamine B12 étaient de : 838, 445, 764, 695, 881, 390, 405, 400 pg/ml respectivement. **Conclusion** Cette étude limitée dans laquelle un supplément modeste de vitamine B12 (100 microgrammes deux fois annuellement) a été donné, n'a démontré aucun effet néfaste sur des concentrations sériques en vitamine B12 pendant une période allant jusqu'à 10 années après la confection d'une poche urinaire gastro-intestinale.

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