Enteral Feeding as a Part of Combination Treatment in a Patient after Small Intestine Transplantation

M. Sh. Khubutia, A. A. Ryk, V. V. Kiselev, I. V. Aleksandrova, A. V. Grishin, M. A. Godkov, E. V. Klychnikova, N. V. Shavrina, S. S. Sogreshilin, G. P. Titova, N. V. Borovkova

N. V. Sklifosovsky Research Institute of Emergency Care, Moscow

Objective: **to describe the first experience with an enteral feeding regimen used as part of combination therapy in a patient after small intestine transplantation (SIT).** ***Materials and methods*****. The results of treatment in a 48year-old male after heterotopic SIT for short bowel syndrome were given. The extent of the graft was 250 cm. The combination treatment aimed to restore graft functions and included immunosuppressive, infusion, transfusion, antibacterial, antiviral, and detoxification therapies and parenteral and enteral feeding (EF). Our elaborated EF regimen was divided into 3 steps: 1) early enteral therapy (on day 1) using a monomeric saline enteral solution and a specialized formula containing pharmaconutrients (glutamine, antioxidants, and tributyrine); 2) incorporation of a semielemental formula (on day 5); 3) use of polymeric formulas and clinical nutrition. Laboratory, ultrasound, radiological, and endoscopic monitoring and biopsy were performed.** ***Results*****. The combination treatment using stepwise EF could satisfy a patient's protein-energy needs. Restoration of histological structures in the graft mucosa was observed during morphological examination on day 7. At enteroscopy, the intestinal mucosa was pink with prominent villi, motility, and bile-colored chyme. On day 7, there was a 150-ml self-colored stool. Data confirmed that the intestinal graft restored absorption and parietal digestion. On day 30, the patient was switched to polymeric formulas and curative diet. By the discharge from hospital, on day 86, his body mass index was 23.1 kg/m^2.** ***Conclusion*****. The positive treatment results in the patient became possible after SIT due to improvement of surgical techniques, current immunosuppression, and a comprehensive approach to treating him in the postoperative period. Our elaborated stepwise EF regiment is an important component of combination therapy after SIT and facilitates the restoration of the major functions of the transplanted intestine and its preparation for the assimilation of polysubstrate formulas and natural foods.** ***Key words:*** **small intestine transplantation, enteral feeding, glutamine.**

Introduction

SBT is the only radical treatment in case of short bowel syndrome associated with severe intestinal failure, when conservative therapy proves ineffective. Post-SBT treatment is a complex problem. A wide spectrum of complications is the main challenge. On the one hand, small bowel has immune defense and has a potent lymphoid tissue component, containing about 80% of total body's lymphoid cells weight. It makes the suppression of the graft rejection reaction difficult and requires aggressive immune suppression for rejection episodes prevention and treatment. On the other hand, small bowel graft, having no of normal innervation and lymphatic drainage at the initial stages has a strong tendency for wall edema and paresis. Barrier function disorder of the small bowel results in bacteriaemia episodes; under the condition of severe immunity suppression with high the risk of sepsis. Long term and aggressive immune suppression is associated with a higher risk of these complications. It results in increasing risk of episodes rejection, infections and graft loss both at early and late post-transplantation periods.

Modern specialized multidiscipline centers enable effective complex treatment in post-SBT patients, directed to graft functions preservation. In recent years modern immunosuppression regimens, improved surgical techniques and post-operation management result in higher number of SBT operations and better outcomes [1, 2].

Nutritional support particularly enteral nutrition (EN) is one of the main components of post-SBT treatment. EN has particular characteristics and is based on various assessment methods evaluating both the graft and other organs taking part in digestion. Special attention is paid to early initiation of minimum tube EN [U. Suchner et al., 2000]. It is initiated within 24 hours after the operation using 300—500 ml/day volumes and slow administration rate — 20—30 ml/hour. Minimum EN wouldn't support the need for proteins and energy; however, it is the nutrition of graft mucosa cells, improvement of lumen nutrition gastrointestinal organs and maintenance of intestinal barrier function. Balanced and individually adjusted EN contributes to suppression of stress reaction and hyper-catabolism, enabling rapid recovery of basic intestinal functions [3—6].

Original solutions for enteral administration was developed by Professor Yu. M. Galperin at Sklifosovsky Research Institute for Emergency Medicine. The electrolyte content of these solution is similar to natural intestinal chyme (salt-based enteral solution; monomers and salt based enteral solution; monomers and salt-based solution for hypovolemia correction; polysubstrate enteral solution) [7—9].

Special attention is paid to inclusion of various substances with different pharmacological effects into artificial nutrition. These substances influence the severity of inflammation and suppress the catabolism [10, 11]. One of them is EN formula containing glutamine, ω-3 fatty acids and antioxidants. Currently multiple clinical and experimental data demonstrating the positive effect of glutamine

Correspondence to:

Ryk Alla Aleksandrovna
E-mail: alla-ryk@yandex.ru

inclusion into nutrition in patients with critical illness are available [10, 12—20].

The use of glutamine contributes to the decrease of mortality rate and the number of infections [12, 13, 21—23]. In patients who experienced liver transplantation, positive effect of glutamine on the immunity was demonstrated [17]. Glutamine is a potent source of energy; it supports the function of different organs and cells [23—29]. High rate of glutamine absorption is critical for cells with a high mitosis rate (e.g., enterocytes, fibroblasts and lymphocytes [21], where glutamine serves as a precursor of peptides and proteins, as well as amino-sugars, purines and pyrimidines that contribute to synthesis of nucleotides and nucleic acids [30]). In contrast to polymeric formula, it can be absorpted.

At present, both glutamine for intravenous administration and special EN formula containing daily glutamine doses are available. One of these EN formulas containing the complex of pharmacological nutrients is Intestamin (Fresenius Kabi, Germany). Its ingredients are easily absorbed in the intestinal disorders. Intestamin contains glutamine dipeptides, antioxidants and tributyrine; these substances provide nutrition to enterocytes, support the immune and anti-oxidant systems and preserve the barrier function of the intestine. The formula is used at early stages (6 hours since the critical condition onset) along with parenteral nutrition or EN.

Post-SBT EN is directed to the earliest recovery of basic intestinal functions (motility, absorption, digestion, barrier, immune function) in order to prepare the graft to natural nutrition. Gradual increase of administration volume and change of nutrition substrate contents are essential.

Post-SBT treatment requires complex approach. Only appropriate combination of modern treatment methods enables successful operation outcome.

Objectives. Description of EN regimen novel experience as a part of a complex treatment after SBT.

Materials and methods

We have analyzed the treatment outcomes in patient G, 48 years.

Patient was hospitalized in Sklifosovsky Research Institute for Emergency Medicine at 12.10.2012. Before this hospitalization he was operated in another hospital. Subtotal resection of small bowel due to mesenterium vascular thrombosis was performed. The length of remaining small bowel was 35 cm; it had a lateral anastomosis with right half of the transversal colon. The short bowel syndrome developed during the post-operation period. Body weight loss (16 kg) was reported. On admission, the patient complained on fatigue, progressing body weight loss, nausea, and loose stools (up to 4—6 times daily). BMI — 21,6 kg/m^2 (weight — 70 kg, height — 180 cm). The patient received complex therapy directed to short bowel syndrome manifestations management. Adequate enteral and parenteral nutrition was provided. However, no significant improvement was reported. Therefore, heterotopic SBT was conducted on February 24, 2013. Graft length — 250 cm; jejuno-jejunal anastomosis was formed between the remaining part of patient's intestine and the graft within 40 cm from its proximal part. The proximal part of the graft was exposed externally as the enterostoma in the left hypochondriac region; ileo-transversal anastomosis was formed between the graft loop and patient's transversal colon. Double barreled tube №25 silicon was introduced into the graft's lumen through the anastomosis for decompression and nutrition. Cold ischemia duration — 3,5 hours, warm ischemia duration — 40 minutes.

During the post-operation period, the patient was receiving complex parenteral nutrition and EN support for proteins and energy and gastro-intestinal functions recovery. Indexes of nutrition insufficiency and discrepancies between ideal and actual body weight were calculated. The equation of Harris — Benedict was used for calculation of energy requirements; various factors were included: activity level, damage, temperature factor and body weight deficiency. The need for proteins (based on nitrogen balance including stoma and drainage losses), lipids, carbohydrates, electrolytes and vitamins were included into calculations. Standard clinical and biochemical blood and urine analyses were conducted.

Nutrition efficacy monitoring included daily evaluation of glycemic, lipid and protein profiles, plasma electrolytes, liver function tests, cholesterol level, absolute leukocyte counts and anthropometry parameters. Nitrogen balance control was conducted daily throughout the first 14 days; later it was conducted at least twice a week. Body weight and water balance were controlled daily throughout the hospitalization.

Regular ultrasonic, X-ray and endoscopy with biopsy were conducted in order to control the gastro-intestinal organs condition and the small bowel graft.

Fibro-colonoscope Olympus Q 160 AL was used for enteroscopy. Examination was conducted through the enterostoma in the left hypochondriac region. Small bowel mucosa of the graft and patient's intestine and jejuno-jejunal anastomosis between the patient's intestine and the graft (40 cm from enterostoma) were evaluated. Biopsy of small bowel graft mucosa and from remaining recipient's intestine was taken during the enteroscopy at Days 3, 7, 14, 21, 28 and 60 after the operation at 10, 20 and 30 cm from the enterostoma margin.

Biopsy samples of small bowel graft mucosa taken within 3, 7, 14, 21, 28 and 60 at 10, 20 and 30 cm from the enterostoma margin were evaluated morphologycally. Biopsy samples from remaining recipient's small bowel were used for comparison. Carnoit's fluid was used for biopsy samples fixation; samples were immobilized in paraffin. Hematoxilin/eosin staining and periodic acid Schiff reaction were used for staining.

Treatment methods. Intensive complex treatment was conducted in the post-operation period. The aim of such treatment was to preserve the graft function. Treatment included immunosuppressive therapy, intravenous infusion therapy, transfusion therapy and substitutes, anti-aggregation (anticoagulants) treatment, antibacterial, antiviral and antifungal therapy, blood purification therapy and anti-ulcer therapy. EN and parenteral nutrition were essential components of the treatment regimen. Volume, administration route and administration rate were based on established values and absorption rate.

Parenteral nutrition during the first 2 days of the post-transplantation period consisted of glucose and amino acids solutions. Since Day 3, the «all-in-one» solution was administered; it contained glucose solution, amino acids and last generation IV Fat Emulsion (containing soya oil, medium chain triglycerides, olive oil and fish oil). Volume adjustment was based on the patient's need for proteins and energy. Parenteral form of glutamine and vitamins in daily doses were administered additionally. Double barreled catheter with a cuff was used for continuous access to blood vessels. Special attention was paid to prevention of infections and thrombophlebitis.

EN was directed to the maintenance of graft mucosa structures and early recovery of its basic functions (motility, absorption, digestion, barrier and immune functions) in order to prepare the intestine for oral nutrition. EN regimen was based on step-by-step change of nutrition substrate volume and content. EN components tolerability and graft condition were considered.

EN regimen included 3 stages: stage 1 — early enteral treatment (since Day 1) using monomers and salts based enteral solu-

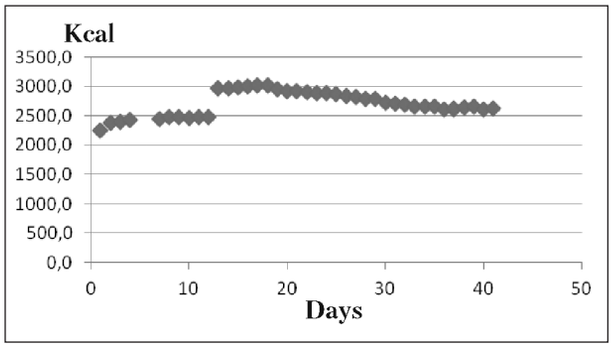


Fig. 1. Change of energy need in a patient after small bowel transplantation.

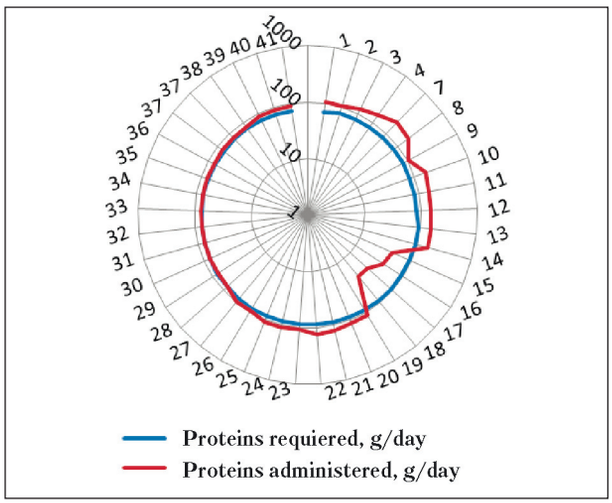


Fig. 2. Change in protein requirements compensation in a patient after small bowel transplantation.

tion and specialized EN formula Intestamin, containing pharmacological nutrients (glutamine, antioxidants and tributyrine); stage 2 — tube and oral EN (since Day 5) using hydrolyzed EN formula (Peptamen type); stage 3 — conversion to balanced polymeric EN formula using sipping method and oral diet therapy along with the recovery of absorption and digestion functions.

Early EN was initiated on Day 1 with infusion of monomer and salts based enteral solution (500 ml/day). Post-SBT balance of introduced volume and tube excretion demonstrated satisfactory absorption level. Since Day 2, specialized EN formula Intestamin containing pharmacological nutrients (glutamine, anti-oxidants, tributyrine) was added (300—500 ml/day, slow infusion throughout the day). EN formula was administered through the tube introduced into the enterostoma and the graft intestine; total daily volume was 600—800 ml/day. Long-term administration (approximately 20 hours per day) and slow administration rate (20—30 ml/hour) were used. Since Day 5, administration of Intestamin (500 ml/day) was supported by additional administration of hydrolyzed EN formula (100 ml/day). Administration of the nutrients was not associated with dyspepsia. Daily administration of Intestamin into the graft intestine through the tube (daily volume 500 ml/day) was continued for 24 days. The dose of hydrolyzed EN formula was increased from 100 to 500—800 ml/day, along with absorption improvement. Since Day 7, additional oral gavage of hydrolyzed EN formula was initiated (low doses — 50 ml, 3—5 times daily). On Day 7 independent defecation occurred (volume — 150, colored feces). By Day 10, the volume of feces was 700 ml.

Along with graft adaptation and absorption recovery oral gavage with polymeric EN formula, using the sipping method was initiated since Day 22. Since Day 30, additional specialized oral

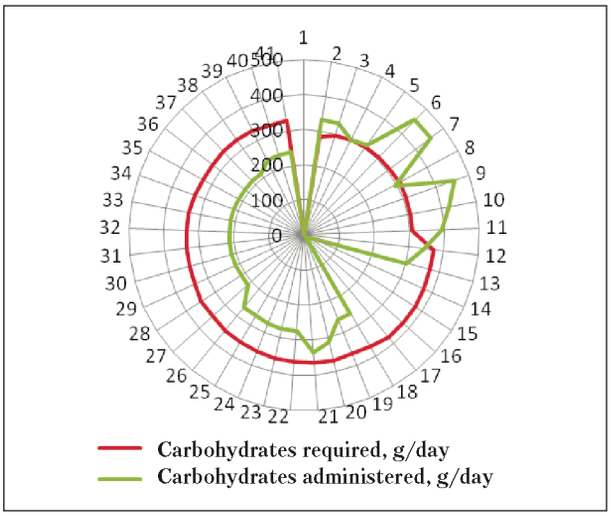


Fig. 3. Change in carbohydrates requirements compensation in a patient after small bowel transplantation.

diet therapy was initiated (high protein content, low fat content, low carbohydrate and allergens content), using easily digested products and small portions (6—8 times daily). Oral feeding could not have been started earlier due to two episodes of graft dysfunction associated with early cellular rejection reaction.

Complex therapy included EN initiation and oral formulations of poly-enzyme spasmolytics. Anti-ulcer therapy was conducted since Day 1 of the post-operation period; parenteral administration of proton pump inhibitors was conducted. Later these medicines were administered orally.

Standard 4-components immune suppression regimen was used: poly-clonal antibodies Atgam ATX (Immunoglobulin antithymocyte), Solu-medrol (Methylprednisolone), natural macrolide mycophylline agonist Tacrolimus (Prograf), and proliferation signal inhibitor Serolimus (Sertican).

Bacteriophages were used for prevention of bacterial translocation from the intestinal lumen and micro-biocenosis recovery; bacteriophages had an ability of specific destruction of staphylococci, streptococci, pathogenic intestinal bacteria, *Pseudomonas Aeruginosa, Proteus mirabilis, Proteus vulgaris, Klebsiella pneumoniae,* prebiotics (pectine) and probiotics (Bifidobacterium).

Antibacterial treatment was based on bacterial susceptibility, evaluated during the inoculation of media. Antifungal and antiviral therapy was initiated since the post-operation day 1 and continued until the date of discharge.

Results and discussion

Energy expenses after SBT: Day 1 — 2253,2 Kcal (35 Kcal/kg/day), Day 10 — 2463,4 Kcal (40 Kcal/kg/day), Day 21 — 2928,9 Kcal (45 Kcal/kg/day), Day 40 — 2617,1 Kcal (42 Kcal/kg/day) (Figure 1).

Need for proteins by Day 10 1,4 g/kg/day, Day 21 — 1,6 g/kg/day, Day 40 — 1,3 g/kg/day (Figure 2). BMI at the early post-operation period 18,9 kg/m^2.

Combination nutrition (parenteral and enteral) as a part of intensive therapy regimen enabled compensation of patient's energy and protein expenses throughout the hospitalization period (Figure 2—4), as demonstrated by laboratory and instrumental evaluations. By days 18—21 normal protein turnover and positive nitrogen balance were reported (Figure 5).

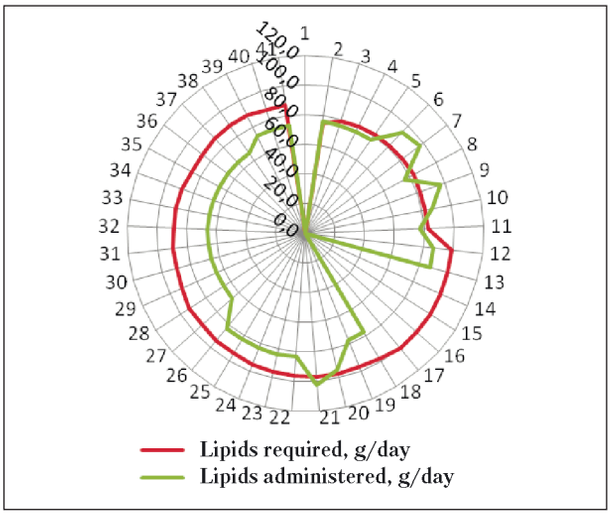


Fig. 4. Changes in fat requirements compensation in a patient after small bowel transplantation.

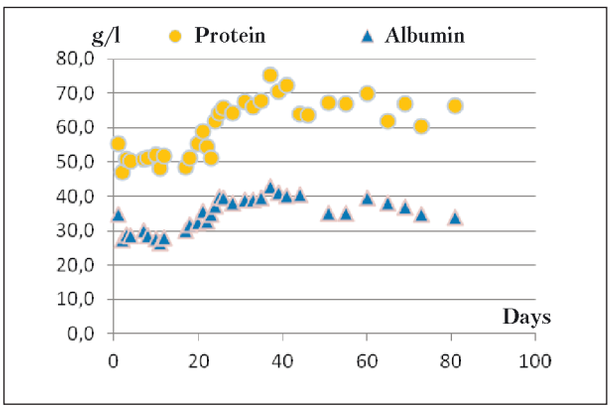


Fig. 5. Change of total plasma albumin level in a patient after small bowel transplantation.

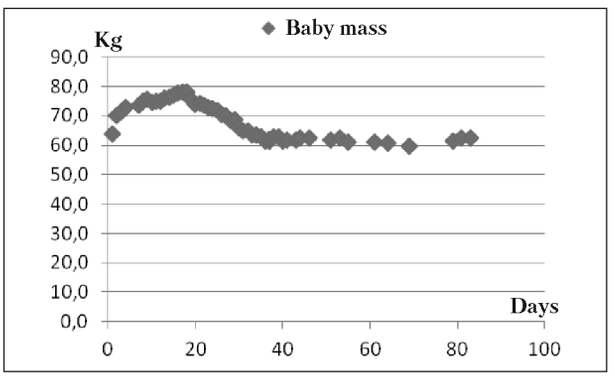


Fig. 6. Change of body mass in a patient after small bowel transplantation.

Body weight increased at the early post-SBT period; later it decreased up to the pre-operation period. We suggest it was associated with post-operation hyperhydration with further normalization of water balance. Later we managed to maintain a satisfactory body weight throughout the hospitalization period with a tendency to gradual increase (Figure 6). BMI at the discharge period was 23,1 kg/m^2.

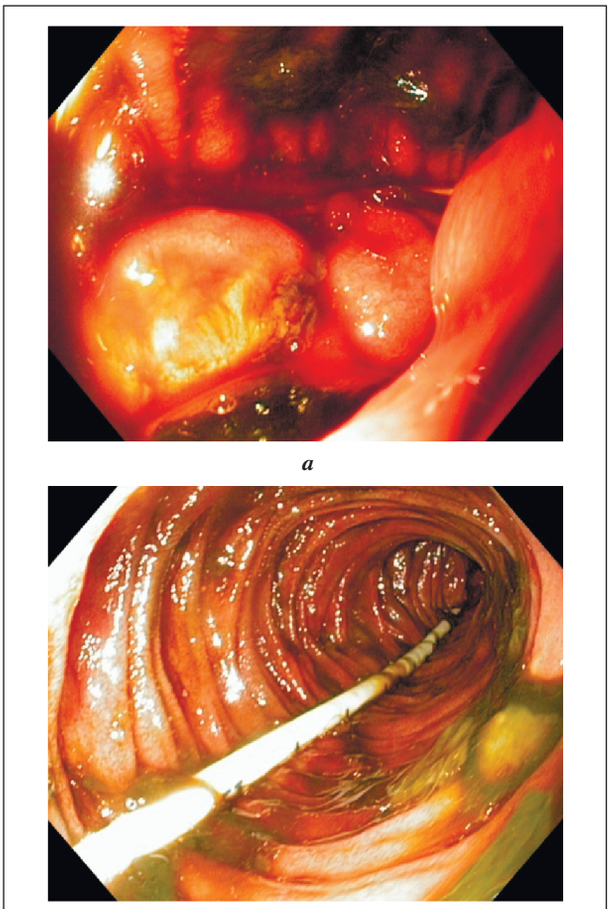
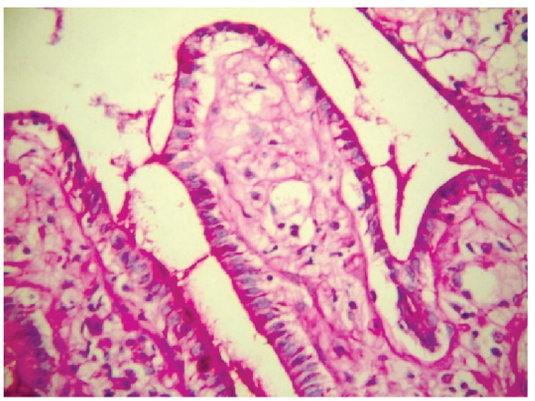


Fig. 7. Endoscopy photo of the small bowel graft at post-transplantation Days 3 (*a*) and 11 (*b*).
a — two acute ulcers — sizes 1,2×0,4 cm and 0,8×0,1 cm, depth less than 0,1 cm; *b* — 25—30 cm higher to anastomosis: pink mucosa with definite villi, peristalsis and bile-stained chyme.

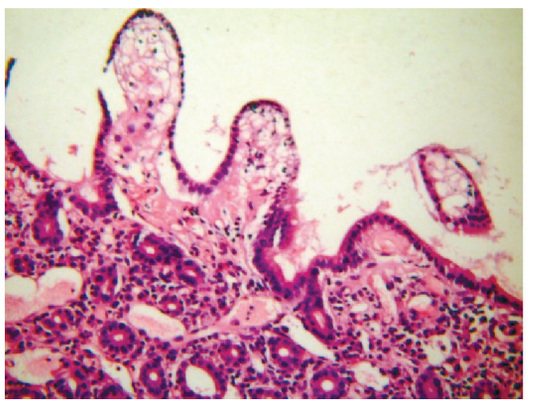
Complex step-by-step treatment resulted in recovery of parietal digestion and absorption in the graft intestine, as demonstrated by endoscopy, histology and radionuclide evaluation.

Endoscopy results: evaluation of graft tissue on post-operation Day 3 — 2 acute ulcers (size 1,2×0,4 cm and 0,8×0,1 cm, depth less than 0,1 cm); complete scarring was reported on post-operation Day 11 (Figure 7*a*). Dynamic graft enteroscopy, 25—30 cm higher to anastomosis: starting after Day 7 pink mucosa with definite villi, peristalsis and large volume of bile-stained chyme were observed (Figure 7*b*).

Histology of graft tissues: post-operation Day 3 — shortened and flattened villi with thin superficial epithelium in the apical areas of villi, lack of goblet cells, poorly visible brush border. Absorptive epithelium was found on the lateral villi surfaces only; it had thin brush border. Intestinal villi stroma — edema, signs of unequal blood supply of sub-epithelium capillaries, and widened lymph vessels. Mucosa crypts: increased number of stroma cells compared to remaining recipient's intestine — mostly due to mononuclear infiltration; no signs of peri-vascular or peri-glandular orientation,

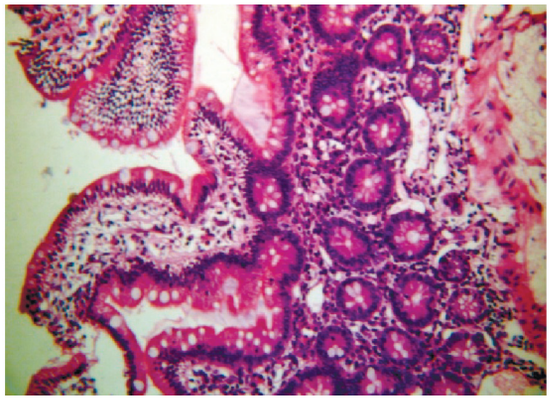


a



b

Fig. 8. Shortened intestinal villi, flattened epithelium in apical portions of villi, diffuse mono-nuclear infiltration and edema of stroma, lymph vessels lumen dilation (*a*). Staining: hematoxilin — eosin, ×250. Thin blurred brush border of villi epithelium, goblet cells hypoplasia (*b*). Schiff's reaction, ×400.



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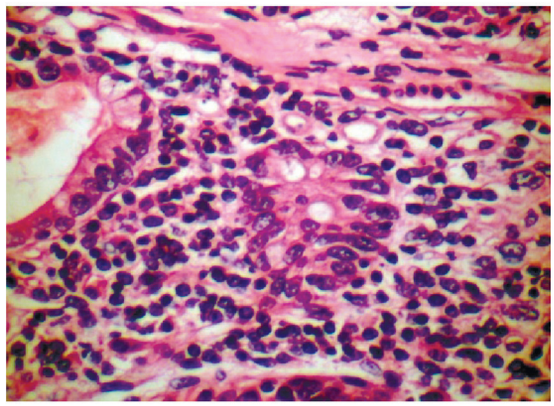

b

Fig. 9. Intestinal villi histological structure restoration; regeneration of absorptive epithelium (*a*). Staining: hematoxilin — eosin, ×250. Diffuse mono-nuclear infiltration of mucosa crypts stroma; cells are distributed along the basal membrane of glands, no epithelium damage (*b*). Staining: hematoxilin — eosin, ×400.

basal membranes and crypt epithelium destruction were found (Figure 8 *a*, *b*). The changes of small intestine mucosa morphology correspond to post-hypoxy changes of the graft with a mild acute cellular rejection. They demonstrated absorption function disorder in the graft tissue.

Post-transplantation Days 7—10: recovery of intestinal villi structure, elongated villi lined with absorptive epithelium with regular goblet cells with definite brush border on the surface of villi. It demonstrated recovery of absorption and parietal digestion functions (Picture 9*a*). Increased mono-nuclear stroma infiltration, involving lamina muscularis propria was found; cells were distributed along basal membranes of glands, no damage of crypt epithelium was found (Figure 9*b*).

Histologic analysis of biopsy samples throughout the study period (Days 21, 28 and 60): no changes of intestinal villi structure, intestinal epithelium, blood and lymph epithelium were found; increased mononuclear infiltration of mucosa stroma was found, lamina propria and glands were not involved into the infiltration process (Figure 10).

Two episodes of graft rejection reaction were reported during the post-transplantation period. Histology analysis demonstrated acute rejection reaction at Days 8 and 14;

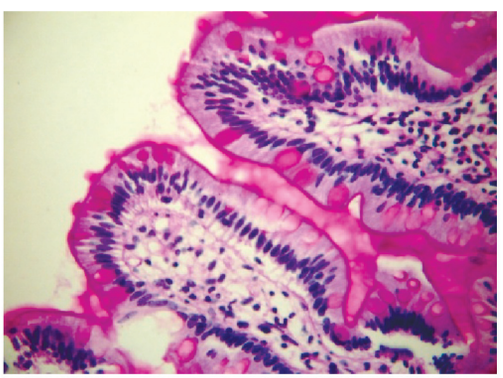

Fig. 10. Wide glycocalyx layer of the absorptive epithelium brush border with regular location of goblet cells. Schiff's reaction, ×400.

it was manifested by mono-nuclear infiltration. Pulse-therapy with methyl-prednisolone was conducted at the respective periods.

Ultra-sonic: post-operation Day 1 — graft wall thickness 0,4—0,5 cm, decreased echo-response of the wall,

pronounced peristalsis suppression. Week 1: intestinal wall thickness was within 0,3—0,4 cm, with differentiated layers, heterogeneous content and visible peristalsis. At days 8—9, 14 and 1,5 months after transplantation: 10 cm fragment of intestine was detected in the left meso — and hypogastric areas, with wall thickened up to 0,4 cm, and differentiated layers; suppression of blood circulation in the intestinal wall and lack of peristalsis were reported. These changes persisted during 2—3 days followed by symptoms regression. In other areas of the intestine the thickness of the wall was within 0,2—0,3 cm, with good differentiation of layers and visible peristalsis. Evaluation of blood circulation in the intestinal wall: intestinal arteries resistance index was variable — from 0,6 to 0,78, without clear correlation; systolic peak rate — from 19 to 56 cm/sec, final diastole rate — from 5,5 cm/sec to 26 cm/sec.

Large intestine wall edema in all regions was reported throughout the first week; it was manifested by decreased echo-response and increased wall thickness up to 0,4 cm. Since Week 2, the wall thickness increased up to 0,7—1,0 cm. Since Week 3 edema regression was reported: wall thickness 0,5—0,6 cm, wall layers are well differentiated with increased echogenicity and a small amount of heterogeneous content in the lumen.

X-ray examination: post-operation Week 6 — motor and evacuation function disorders were demonstrated in the small bowel graft; normalization of motility was reported by Weeks 11—12.

Baseline normal bacterial content enabled prevention of serious purulent and septic complications after SBT. Single episode of *Staphylococcus aureus* and *Enterococcus* spp. Detection in blood was reported at Week 6. Dysbiotic changes of gastro-intestinal tract flora was associated with Bifidobacterium and Lactobacterium deficiency, presence of *Candida* and *Enterobacter* spp., *Klebsiella* spp. and *S.aureus*. Similar bacteria were found in pharynx. Correction of gastro-intestinal flora with 2% pectine solution and probiotics resulted in elimination of conditionally pathogenic bacteria.

The following complications were reported during the post-operation period: chylous ascites during the post-transplantation Week 1, pancreatitis; bilateral inferior lobe pneumonia, occlusion thrombosis of sinister brachial vein and sinister internal jugular vein, episodes of acute renal failure and manifestations of encephalopathy were reported later. Echo-signs of small foci pancreatic necrosis with retroperitoneal adipose tissue edema were reported after post-operation period Day 3 during 6 weeks; manifestations of omentobursitis and reactive cholecystitis persisted during 2 weeks. Conservative treatment was applied to manage these manifestations.

At the moment of discharging the patient was receiving combination nutrition — supporting parenteral nutrition (small volumes, 2—3 times weekly), plus oral gavage of specialized EN formula (sipping method) and dietary nutrition. Protein metabolism parameters were normal; BMI was 23,1 kg/m^2. Functional status of small intestine graft was satisfactory. Patient was discharged on post-operation Day 86, total duration of the hospitalization period — 213 days.

In 7 Month after transplantation the patient was followed up in outpatient setting, patient's condition was satisfactory. Patient was receiving oral nutrition and maintaining stable body weight.

In the post-SBT period the small bowel graft initially had no of normal innervation and lymph drainage, had a strong tendency to wall edema and paresis. Therefore, maintaining structure of graft mucosa and rapid restoration of basic intestinal function (motility, absorption, digestion, barrier and immune functions) are essential in order to prepare it to natural digestion. Only application of complex intensive therapy methods (immunosuppressive therapy, intravenous infusion therapy, transfusion therapy and substitutes, anti-aggregation therapy, anti-bacterial, anti-viral, anti-fungal therapy, blood purification therapy, anti-ulcer therapy, parenteral and enteral nutrition) during the post-operation period resulted in positive treatment outcome.

Artificial nutrition (especially its enteral component) is an important part of post-SBT intensive therapy. EN has special parameters and should be based on tolerability of EN formula components and graft condition. We suggest that step-by-step changing the nutrition substrate contents and volume is essential. Therefore, we developed an EN regimen for the post-SBT period. Our regimen consisted of 3 stages.

Complex therapy plus step-by-step treatment resulted in restoration of intestinal villi structure by Days 7—10, as demonstrated by morphology evaluation. Pink mucosa with definite villi, peristalsis and bile-stained chyme were visible during the enteroscopy. Independent defecation with colored feces (150 ml) was observed on Day 7. It confirmed the restoration of absorption and parietal digestion in the small intestine graft. We suggest that the step-by-step EN regimen significantly contributed to it; in particular, early use of monomers and salts based enteral solution and specialized EN formula containing pharmacological nutrients (glutamine, anti-oxidants, tributyrine) was especially helpful. Enteral solution has chyme-like effects; it stimulates the motility and improves the absorption in small bowel [7, 8]. Glutamine acts as a nutritive media for rapidly dividing cells of intestinal mucosa through improving tissue nutrition and absorption process. Anti-oxidants enhance this process, while tributyrine works as the energy component [21—30]. The combination of these substances during the early post-operation period provides a therapevtic effect on the SBT.

Complex intensive therapy is supported by gradual step-by-step change of EN components and volume along with graft adaptation process. Use of hydrolyzed EN formula on the stage 2 contributed to preparation of the graft to digestion of polymeric EN formula and diet food. As a result, by Day 30 the patient was transmitted to balanced polymeric EN formula using the sipping method and oral diet therapy, supported by parenteral nutrition (small volumes, 2—3 times weekly). Satisfactory protein metabolism parameters and BMI were maintained thus indicating restoration of absorption and digestion functions of the graft.

Further studies in similar patients are required to evaluate the efficacy of separate components of described complex regimen.

Conclusion

Improved surgical technique, modern immunity suppression methods and complex approach to post-operation treatment result in positive outcomes of SBT. Our step-by-step EN regimen with early enteral therapy includes chimus-like enteral formula and pharmacological nutrients (glutamine, anti-oxidants, tributyrine) with further step-by-step change of nutritive substrates contents and volume is an important component of post-SBT complex therapy; it contributes to restoration of the transplanted small bowel function and prepares it to digestion of polymeric EN formula and oral food.

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Submitted 15.05.2013