

Progressive Preoperative Pneumoperitoneum (PPP) as an Adjunct for Surgery of Hernias with Loss of Domain

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Rezumat

Pneumoperitoneul progresiv terapeutic (PPT) ca adjuvant în tratamentul herniilor cu pierderea dreptului la domiciliu

Introducere: închiderea forțată a unui defect parietal de mari dimensiuni conduce la rezultate imediate și tardive nesatisfăcătoare în ciuda dezvoltării chirurgiei protetice. Creșterea dimensiunilor abdomenului se poate realiza pe lângă alte metode, cu ajutorul pneumoperitoneului progresiv. Scopul studiului este de a evalua rezultatele imediate ale utilizării metodei la pacienții cu defecte parietale importante.

Material și metodă: în perioada iunie 1998 - iunie 2013, metoda s-a aplicat la 17 pacienți (4 de sex masculin) cu hernii inghinale gigante (3 cazuri) sau hernii incizionale (14 cazuri) primare sau recidivate internați în secția Chirurgie a Spitalului Militar de Urgență Cluj-Napoca. Vârsta medie 64,35 ani. S-au măsurat constantele standard ale funcției respiratorii (CV, VEMS, VEMS/CV etc), gazele sanguine, presiunea intravezicală înaintea injectării aerului, cu 24 de înainte de intervenție și la 7 zile postoperator.

Rezultate: nu s-au consemnat accidente/complicații legate de metoda în sine. S-a obținut ameliorarea semnificativă a funcției respiratorii și creșterea proporțională a presiunii intraabdominale.

Concluzii: rezultatele obținute indică metoda ca fiind de elecție în crearea unei compatibilități între conținut și conținător la pacienții cu defecte parietale gigante.

Cuvinte cheie: hernie incizională, pierderea dreptului la domiciliu, pneumoperitoneu

Abstract

Background: forced repair of a giant abdominal wall defect end with unsatisfactory results despite development of prosthetics materials. The enlargement of abdominal wall dimensions could be realized altogether other methods with the aid of pneumoperitoneum. The aim of the study is to evaluate early results of the method used for patients with giant incisional hernias.

Material and methods: between june 1998 – june 2013, 17 patients (4 males) with giant abdominal wall defects (incisional and inguinal hernias) were prepared for radical surgery with pneumoperitoneum. Average age was 64.35 years. Were evaluated the standard constants of the pulmonary function, blood gases, and intra-vesical pressure in 3 moments: before the first gas insuflation, 24 hours before surgery and in the 7th day postoperatively.

Results: the method was free of accidents or incidents, no mortality was recorded. The respiratory function was significantly increased and also the intra-abdominal pressure.

Conclusion: our results suggest that the method of progressive pneumoperitoneum is safe, costless of choice for creating a clear compatibility between the wall and abdominal content in patients with giant abdominal wall defects. Also ensures a long term and stable improvement of the respiratory function in all it's components.

Key words: incisional hernias, loss of domain, pneumoperitoneum

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Background

Repairing abdominal wall defects (AWD) being primary or incisional is a common problem for the general surgeon. Generally speaking, AWD are classified according with the dimensions of the defect (1,2). In some instances it is more important the volume of the exteriorized viscera and in those instances we are talking about “hernias with loss of domain” (3). Primary or incisional hernias with loss of domain represents, even in the era of modern surgery, a challenge both for the patient but especially for the surgeon. Loss of domain by lateral musculo-aponeurotic retraction, relaxation of the diaphragm and frequent association of obesity and chronic cardio-respiratory diseases turns the patient into a biological and social invalid. Even with a prosthetic aid, the forced repair of such huge defect leads to unsatisfactory results immediately materialized in an abdominal compartment syndrome (ACS) and late, if the patient survives, in a high recurrence rate (4-6).

In this situation the main goal of the surgeon was to enlarge the abdominal wall cavity. As a result more or less effective surgical techniques were adopted: resection of the frenic nerve, various transverse incisions, musculoaponeurotic flaps or even large intestinal resections (7-12). Despite this therapeutic adjuncts, anatomic difficulties related to visceral accommodation could not be solved.

Ian Goni Moreno, an Argentine surgeon, was the first who in 1940, injected oxygen in the abdominal cavity in order to reduce an incarcerated epigastric hernia (13,14). Even if good results were obtained along time this method was poorly accepted and adopted by surgeons.

The aim of this study is to analyze early and late effects of the progressive preoperative pneumoperitoneum (PPP) in the treatment of giant abdominal wall hernias. There is a lack of data in the literature concerning the issue meaning that the subject could be of interest for the readers.

Material and Methods

Patients

Between june 1998 and june 2013 in the Department of Surgery from Military Hospital Cluj-Napoca were admitted 23 patients with giant abdominal wall defects. The decision for pneumoperitoneum was taken in 18 patients according with the impossibility of maintaining the reducibility of hernia at the clinical examination. For the last 5 patients the loss of domain was documented by a CT examination and determination of the hernia sac volume (HSV) and abdominal cavity volume (ACV).

Investigations

All the patients were subjected to a complex evaluation of the current cardiologic, neurologic and general status. An abdominal ultrasound examination and an abdominal plain X-ray were routinely performed. Respiratory function was evaluated by computerized spirometry (VC, FEV1, FEV1/VC).



Figure 1. The materials frequently used is represented by a pleural puncture kit. 1 - the trocar with the indwelling cateter; 2 - the connector with valves

Astrup samples for blood gases determination were used. The intraabdominal pressure was indirectly measured by intravesical catheterization. All datas were obtained before the pneumoperitoneum, 24 hours before surgery and in the 7th day post-operatively for all patients. In last 3 years the investigation protocol was completed with native abdominal CT scan to evaluate the volumes of the cavity and of the hernia sac. A volume ratio (VR) HSV/ACV over 25% was suggestive for loss of domain (15).

Pneumoperitoneum

To establish the PPP a pleural catheter device (Pleuracan™ - B Braun Melsungen) with trocar and 3 valves required to maintain the air in peritoneal cavity was used (Fig. 1).

Abdominal cavity was approached by puncture under local anaesthesia with 100-150 mg 1% Xylocaine. The site of insertion was chosen so as to be far away from hernia or skin scars in order to prevent extension of an unpleasant trocar site infection. The pneumoperitoneum was maintained by daily insufflation of various volumes of atmospheric air until the reduction of hernia was obtained. Daily volumes were variable and the administration was stopped when the patient acused nausea or pain in shoulders. For the whole period of time the prophylaxis of deep vein thrombosis (DVT) was maintained by subcutaneous daily administartion of a single dose of low molecular weight heparine - 2500 U Fragmin™ (Pfizer HCP Corporation – Pharmacia & Upjohn).

The ethic local hospital committee approved the study before its implementation.

Surgical procedure

Standard surgical procedure for the whole patients was the retromuscular insertion of a large sheet of polypropilene mesh according to Rives and Stoppa (4).

Statistical analyse

Datas were expressed as mean with standard deviation (sd); variables were compared with the t-Student test (index of statistical significance $p < 0.05$) and correlate with the Pearson (r) test. Statistic software Excel sub Windows 2003 was used.

Results

17 patients remained in the study. One death was recorded in a patient with a large left inguino-scrotal hernia who, in the 2nd day of PPP developed a urinary sepsis and decesead with MSOF after 17 days of ICU therapy. No mortality and morbidity related with the procedure was recorded. Demographic data and exclusion criterias are listed in Table 1.

There were 3 males with giant inguinal hernias and 14 patients (1 male) with incisional hernias: 5 primary and 9 recurrent (Figs. 2, 3). The rank of recurrence is presented in Table 1.

Placing of the PPP catether was in left inferior quadrant in 9 patients, in the left flank for 3 patients and in the left upper quadrant in 5 instances. In 8 patients the procedure was initiated and maintained in an ambulatory fashion. Comorbidities are listed in Table 1. Patients with 2 associated comorbidities were included in high risk group and they represent 11 of them.

The mean insufflation period was about 21 days and the medium volume of instilled air was 1000 ml. Datas are shown in Table 2.

Respiratory function values before and after PPP are represented in Table 3.

Discussions

Pneumoperitoneum is the injection of air or other gas in the

Table 1. Demographic data and exclusion criteria for patients with hernias with loss of domain. *Data expressed as average $\pm$ standard deviation. ASA - American Society of Anesthesiologists. COPD - Chronic Obstructive Pulmonary Diseases

Age (years)*	64,35 $\pm$ 4,54 (min 58 - max 73)
Gender (female : male ratio)	13:4
Body Mass Index (kg/m ²)*	29,29 $\pm$ 1,82 (min 26 - max 32)
ASA score	2 – 14 patients
	3 – 3 patients
Exclusion criterias	Body Mass Index > 35kg/m ² - 3 patients
	ASA > 3 – 1 patient
	Severe COPD – 2 patients
Rank of recurrence for incisional hernias	1 recurrence – 4 patients
	2 nd recurrence – 2 patients
	3 rd recurrence – 2 patients
	6 th recurrence – 1 patient
Associated diseases	Diabetes mellitus – 3 patients
	Severe arterial hypertension - 12 patients
	COPD – 6 patients
	Smokers – 9 patients
	2 or more comorbidities - 11 patients

abdominal cavity for diagnostic or therapeutic purposes. For the first time the method was used in 1931, before the advent of streptomycin, for cavitary tuberculosis and was based on the fact that diaphragmatic ascension induce variable degrees of pulmonary collapse wich was beneficial for cavities healing (12). Intra-peritoneal gas insufflation (preferably atmospheric air not O₂ or CO₂ because of their rapid absorbtion) could be done in a continuous or fractioned manner (14). Progressive



Figure 2. Giant bilateral inguinal hernia



Figure 3. Giant 3rd time recurrent incisional hernia

Table 2. Technical characteristics of the pneumoperitoneum; data expressed as average with standard deviation. * only for last 5 patients in the study; ** Volume ratio is the ratio between volume of the hernia sac (HSV) and abdominal-cavity volume (ACV). If the ratio is great than 0,25 the hernia is with loss of domain

Insufflation time (days)	min 12 - max 32 (21,63 ± 5,44)
Air volume/insufflation (ml)	min 600 - max 1500 (1081,81 ± 25,26)
Total insufflated air volume (ml)	min 10.800 - max 38.400 (13.590 ± 8443,74)
Hernia sac volume (HSV) (ml)*	min 1850 - max 5800 (3910 ± 875)
Volume ratio (%)**	min 26 - max 68 (45 ± 3)

administration of the air induces gradual elongation of the abdominal wall such that facilitates intraoperative or sometimes even preoperative reduction of the hernia content and allows fascial reconstruction under low parietal tension. Although over the years many authors have suggested this effect of PPP (8,13, 14,16-21) the assumption was demonstrated for the first time by the school of Amiens (22). In a recent study on 21 patients with medium and large incisional hernias who underwent pneumoperitoneum was demonstrated by CT scans performed before and after injection, an increase in the total length of parietal muscles with 83 mm ($p < 0.001$). More recently, in a volumetric CT study Lardi re - Deuelte et al, found an increase of the abdominal cavity volume of 49% after

the implementation of PPP (the increase has a statistical significance with the p value < 0.05)(3).

Besides musculo- aponeurotic wall distension, increased volume of the peritoneal cavity is achieved at the expense by lifting of the diaphragm (Fig. 4).

This is one of the effects of particular importance because in parallel the pneumoperitoneum produces a marked and stable improvement of the respiratory function of the patient.

Due to the large size of the hernia and the permanent presence of visceral mass in the hernia sac, these patients have a low intra-abdominal pressure that is associated with an imbalance between the intra-thoracic and intra-abdominal pressure. As a result, the diaphragm is weakened and relaxed resulting in respiratory function deterioration by reducing its participation in respiratory dynamics. Studies by Rives et al. revealed by spirometric measurements and blood gasometry a restrictive respiratory reduction up to 45 % of predicted values (23,24).

A very important issue of discussion in the indication for PPP. As a matter of fact the main indication is hernia with loss of domain. But what it means loss of domain? It is no longer accept the dictum "you know it as you see it". Nowadays not every irreducible incisional hernia is considered with loss of domain. It is imperative to obtain a native abdominal CT scan of the patient to evaluate the complexity of the abdominal wall defect. According to Tanaka et al (15) the volumetry of the abdominal cavity is the main indicator for loss of domain. It is quite simple to measure the volume of the abdominal cavity (VAC) and the volume of the herniated viscera or volume of sac

Table 3. The values of the respiratory function show marked mixed chronic respiratory failure at the moment of hospital admission. After PPP and after surgery even if the values are not optimal they show a marked and stable improvement. All data are expressed as minimum, maximum, average and standard deviation. Maximum breathing capacity = maximum frequency $\times$ vital capacity (VC), sampled over 15 sec; normal value is greater than 60l/min; less than 25l/min represents severe respiratory incapacity. IAP – intra-abdominal pressure

Evaluated parameter	Admission (1)	Preoperatively (2)	Postoperatively (3)	Statistic significance (p)
Vital capacity (VC)	1800 – 2200 ml (1967±141,97)	2400 – 2900 ml (2563±162,92)	2300 – 2700 ml (2472±142,06)	$p1/2 < 0.0001$ $p2/3 = 0.0891$ $p1/3 < 0.0001$
Average expiratory volume/s (FEV1)	1000-1400 ml (1181,81±132,8)	1600 – 2000 ml (1754±169,49)	1800 – 2000 ml (1967±141,97)	$p1/2 < 0.0001$ $p2/3 = 0.2241$ $p1/3 < 0.0001$
FEV1/VC	0,55 – 0,63 (0,59±0,03)	0,59 – 0,76 (0,68±0,04)	0,60 – 0,76 (0,68 ± 0,05)	$p1/2 < 0.0001$ $p2/3 = 0.2241$ $p1/3 < 0.0001$
Maximum breathing capacity	28,8 – 35,2 l (30,4 ± 5,3)	38,4 – 46,4 l (41,008 ± 4,9)	36,8 – 43,2 l (39,55 ± 5,2)	$p1/2 < 0.0001$ $p2/3 = 0.0871$ $p1/3 < 0.0001$
PaO ₂	70 – 81% (76±3,74)	76 – 85% (80,9 ± 2,58)	74 – 84% (80,36 ± 2,80)	$p1/2 = 0.0021$ $p2/3 = 0.3201$ $p1/3 < 0.0028$
Pa CO ₂	51 – 56% (53,27±1,48)	47 – 51% (48,81±1,53)	48 – 52% (49,9 ± 1,37)	$p1/2 < 0.0001$ $p2/3 = 0.0471$ $p1/3 < 0.0001$
IAP	6,6–10,8 mmHg (8,05±1,36)	9-12,2 mmHg (11,24±1,2)	10,2 – 13 mmHg (11,78 ± 0,81)	$p1/2 < 0.0001$ $p2/3 = 0.0704$ $p1/3 < 0.0001$



Figure 4. Plain abdominal X-Ray with an aspect of large pneumoperitoneum after 5 sessions of 600 ml air insufflation. The aspect is similar with radiologic findings of perforated peptic ulcer but the dimensions after PPP are more larger. In this situation the height of the air is about 5,5 cm which represents the elevation of the diaphragm

(VHS); a report VHS/VAC higher than 25% it is a good predictor for loss of domain and the patient has to be specially prepared for surgery.

Conclusions

1. progressive preoperative pneumoperitoneum is the method of choice in preparing for surgery of large irreducible hernias also known as hernia with loss of domain;
2. indication is selective only after a CT scan evaluation of the complexity of the defect;
3. improvement of the respiratory function is evident in all patients for all its components (pulmonary, diaphragmatic and abdominal);
4. method is without risk and can safely be done on an outpatient basis. It reduces hospitalization costs by disappearance of severe postoperative complications;
5. beneficial effects on respiratory function are maintained even after surgery due to patient progressive adaptation to high intra-peritoneal pressure levels due to reduced visceral mass.

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