International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

IJMRP

Original Research Article.

Evaluation of Intra-Abdominal Pressure Monitoring in Open Abdomen Management with Dynamic Abdominal Closure: An Institutional Based Study

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ABSTRACT

Introduction: Management of Open Abdomen (OA) was first described by the surgeon Andrew J McCosh in the year 1897, as a technique for the effective management of patients with secondary peritonitis. This therapeutic option was uncommon at that time and after that its use gained much popularity in surgical field for effective damage control and as a tool to prevent abdominal compartment syndrome (ACS). These critically ill patients usually require a standardized and multidisciplinary management that includes surgeons and intensive care personnel.

Materials and Methods: Present study was conducted after obtaining informed consent from all the study participants. Ten OA patients and ten open colectomy (non-OA) patients were registered for the study. Inclusion criteria include those conscious patients greater than 18 years old who are without any neurological impairment. IAP measurements of all the OA patients were conducted in the operating theatre before the induction of anaesthesia. IAP measurements of ten non-OA patients were observed at rest, during coughing and during straining to be compared with the ones of OA patients. Measurements were repeated for consecutive three times with 8 hrs interval.

Results: Ten OA and ten non-OA patients were registered into the study. Then, 139 IAP measurements (69 IAP measurements during OA-NA and 69 IAP measurements for OA + NA) of OA patients were recorded during 23 NPT change. So totally 69 measurements were obtained in non-OA patients. Median age of OA and non-OA patients were considered as 58 (22–79) and 55 (38–67) years respectively. Median BMI of OA and non-OA patient were taken as 25.7 (16–46) and 24.8 (17–38) respectively. Three of the OA patients and four of the non-OA patients were mostly female. There was no statistical difference between OA and non-OA patients on the basis of age, sex ratio and BMI. There was no difference between the IAP measurements of OA + NA, OA-NA and non-OA patients at rest and there was a significant difference between IAP measurements of OA + NA and OA-NA patients during both coughing and straining.

Conclusion: Nowadays the use of OA has gained a huge interest and acceptance that this therapeutic option in critically ill patients with severe intraabdominal pathologies. The most common indications for OA are abdominal trauma, peritonitis, acute pancreatitis and ACS.

Keywords: Open Abdomen, Intra-Abdominal Pressure, ABRA.

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Article History:

Received: 26-11-2017, **Revised:** 19-12-2017, **Accepted:** 04-01-2018

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2018.4.1.154	

INTRODUCTION

Management of Open Abdomen was first described by the surgeon Andrew J McCosh in the year 1897, as a technique for the effective management of patients with secondary peritonitis.[1,2] This therapeutic option was uncommon at that time and after that its use gained much popularity in surgical field for effective damage control and as a tool to prevent abdominal compartment syndrome (ACS). From then, multiple conditions and clinical situations have proven some favourable results when treated with an open abdomen condition like intestinal oedema following excessive resuscitation, shock or massive bleeding, abdominal trauma, those with ruptured abdominal aortic aneurysm and patients with intraabdominal infections or with severe

pancreatitis.[3,4] The mortality rate with patients underwent OA usually exceeds 30% depending on the cohort discussed. And these critically ill patients usually require a standardized and multidisciplinary management that includes surgeons and intensive care personnel.[5]

Various techniques involved for the management of OA have been described which include the Bogota bag, Wittmann patch and negative pressure systems (Vacuum-assisted closure therapy -V.A.C, AB Thera System). Similarly, certain authors have reported multiple combinations of these above methods and currently, negative pressure systems in conjunction with manoeuvres that can prevent abdominal fascial retraction are considered as the preferrable technique in some experienced centres, since they allow better control and assessment of the peritoneal fluid loss, mortality, incidence of infection and enhanced primary closure rates.[6]

OA management is a cumbersome phenomenon which has highly reported high morbidity and mortality.[7,8] The survival rates of OA patients are increased dramatically because of the improvement in OA management strategies and Intensive care facilities.[9,10] The indication for OA procedure is the increase in the Intra-abdominal pressure leading to Abdominal compartment syndrome while IAP increase during physiologic activities like coughing for respiratory system clearance and straining for defecation may be clinically important and can play a critical role in the functional recovery of these patients. Based on our experience and knowledge, there are no data available about IAP measurement during daily activities like coughing and straining in OA patients. Hence, we would like to assess the changes in IAP generated in an OA patient and the effect of negative pressure therapy (NPT) and dynamic abdominal closure systems (ABRA) on the IAP values at rest and during typical physical activities of routine living such as voluntary coughing and straining when comparing them with IAP measurements from the patients undergoing open elective colorectal surgery.

MATERIALS AND METHODOLOGY

Present study was conducted after obtaining informed consent from all the study participants. Ten OA patients and ten open colectomy (non-OA) patients were registered for the study. Inclusion criteria include those conscious patients greater than 18 years old who are without any neurological impairment. IAP measurements of all the OA patients were conducted in the operating theatre before the induction of anaesthesia. IAP measurements of ten non-OA patients were recorded 24 hrs after surgery. OA patient with NPT and ABRA (OA + NA) underwent IAP measurement before NPT has taken off and ABRA was braced. IAP measurements were recorded at rest, during coughing, and during straining. Patients who underwent OA-NA in whom IAP measurement after NPT was taken off and ABRA was completely unbraced. IAP measurements were recorded at rest, during coughing and during straining. From the same patient, repetitive measures were taken and when they underwent NPT. Six measurements were recorded for each OA patient during each NPT change. IAP measurements of ten non-OA patients were observed at rest, during coughing and during straining to be compared with the ones of OA patients. Measurements were repeated for consecutive three times with 8 hrs interval.

Data were analysed using standard statistical methods using SPSS 22 version was used. Descriptive statistics which include means, median, minimum, maximum and standard deviations were used to elaborate the maximum IAP measurement for each measurement for each activity and at rest. The Shapiro-Wilk test was used to assess the normality of variables. Mann-Whitney U test was used to compare the two nonparametric values between two groups. Fisher's exact test was used to compare the ratio between two groups. Multivariate ANOVA test was used to assess the independent variable. One-way repeated measurement of variant analyses was conducted to evaluate the dependent results of repetitive measurements in the same group. P value less than 0.05 was considered as statistically significant.

Table 1: Median of the APACHE II, MPI, and Björck score

Parameter	APACHE II	MPI	Bjorck	Length of OA injury	Width of OA injury
Median	26.3	36	3.7	24	14.5
Minimum	19	28	2.1	16	13
Maximum	27	44	4	43	51

Table 2: Mean, standard deviation, minimum and maximum value of IAP of OA-NA, OA + NA, and non-OA patients

		Mean IAP (mmHg)	S.D	Minimum	Maximum
Resting	**OA-NA**	6.2	1.3	4.5	8.9
	OA+NA	6.7	0.9	5.3	8.3
	Non-OA	6.1	1.4	3.0	9.2
Straining	**OA-NA**	11.7	1.7	9.8	14.5
	OA+NA	17.8	3.5	11.2	22.3
	Non-OA	23.7	5.3	15.6	33.9
Coughing	**OA-NA**	11.7	1.3	9.8	14.7
	OA+NA	19.3	4.3	11.6	25.2
	Non-OA	22.4	4.2	15.4	30.9

Table 3: Statistical analyses of IAP measurement of OA-NA, OA + NA, and non-OA patients at rest and during coughing and straining

	A	B	Mean difference	P – value
Resting	**OA-NA**	**OA+NA**	-0.452	0.599
	OA+NA	**Non-OA**	0.513	0.432
	Non-OA	**OA-NA**	-0.065	1.002
Straining	**OA-NA**	**OA+NA**	-6.002	0.0
	OA+NA	**Non-OA**	-6.124	0.0
	Non-OA	**OA-NA**	11.896	0.0
Coughing	**OA-NA**	**OA+NA**	-7.665	0.0
	OA+NA	**Non-OA**	-2.922	0.023
	Non-OA	**OA-NA**	10.566	0.0

RESULTS

Ten OA and ten non-OA patients were registered into the study. Then, 139 IAP measurements (69 IAP measurements during OA-NA and 69 IAP measurements for OA + NA) of OA patients were recorded during 23 NPT change. So totally 69 measurements were obtained in non-OA patients. Median age of OA and non-OA patients were considered as 58 (22–79) and 55 (38–67) years respectively. Median BMI of OA and non-OA patient were taken as 25.7 (16–46) and 24.8 (17–38) respectively. Three of the OA patients and four of the non-OA patients were mostly female. There was no statistical difference between OA and non-OA patients on the basis of age, sex ratio and BMI. For OA patients, median value of APACHE II, MPI, Björck score, width & length of OA wound at first NPT application were tabulated in Table 1. The mean, SD, minimum, and maximum values of IAP measurements of OA-NA, OA + NA, and non-OA patients during resting, straining, and coughing were demonstrated in Table 2. There was no difference between the IAP measurements of OA + NA, OA-NA and non-OA patients at rest and there was a significant difference between IAP measurements of OA + NA and OA-NA patients during both coughing and straining which was shown in Table 3. The mean of IAP measurements of OA-NA patients increased to 11.7 mmHg and the mean of IAP measurements of OA + NA patients to 17.8 mmHg during straining, application of NPT and ABRA provided an average of 6.0 mmHg more increment in the mean of IAP measurements during straining (CI 95 % 8.6/ 3.3) (Table 3). While the mean of IAP measurements of OA+NA patients increased to 11.2 mmHg and the mean of IAP measurements of OA + NA patients to 19.3 mmHg during coughing, application of NPT and ABRA provided 7.7 mmHg more increment in the mean of IAP measurements during coughing (CI 95 %, 10.2/5.06) (Table 3). Mean of all IAP measurements of non-OA patients during straining and coughing were significantly different from the mean of IAP measurements of both OA-NA and OA + NA patients. Mean of IAP of OA + NA patients was related to the mean of IAP measurements of non-OA patients when compared to mean of IAP measurements of OA-NA patients during straining and coughing as shown in Table-3.

DISCUSSION

When observed IAP values during daily activities has not been yet evaluated in OA patients till date. Therefore, this is reported to be the first study by evaluating IAP increase during coughing and straining in OA patients who are managed by NPT and ABRA application. No reported difference in the mean of IAP measurement at rest in OA-NA, OA + NA and non-OA patients were identified. Application of NPT in adjunct with ABRA have not increased IAP at rest but provided significant IAP increase in OA+NA patients when compared to OA-NA patients during coughing and straining which is recorded lesser than the IAP values of non-OA patients. Coughing and straining are critical functions for OA patients which is similar in the other critically ill patients in ICU. So, these OA protocols (NPT and ABRA) prevent resting IAP increase to cause ACS which might offer some secondary advantages to OA patients living on a routine struggle of coping it with ICU care in which increase in some daily activities such as coughing and straining were observed. *Cobb* et al in their study have observed 20 healthy young adults with no previous history of abdominal surgery that the maximum IAP was 127 mmHg during coughing at sitting position and 141 mmHg at standing. For using valsalva manoeuvre in this healthy adult population, the maximum pressures were 64 mmHg at sitting and 116 mmHg at standing.[8] The IAP measurements after intraabdominal surgery in both OA and non-OA patients at supine position, the value of IAP measurements during coughing and straining were observed variability than the other studies. It should be anticipated that there is a wide range of factors in confirming the effectivity of coughing and straining in those complex critically ill patient group; in order to get homogeneity, IAP measurements were recorded preferably at supine position. Hence in this study, the measurement of urinary bladder pressure through a bladder catheter has been used as an indirect method of assessing IAP.[1] *Stokes* et al have reiterated that antagonistic activation of abdominal muscles and intra-abdominal pressurization produces spinal unloading, that has less magnitude of spinal compression with higher IAP values.[11] They have also spotted that curved abdominal muscles are required to control the intra-abdominal pressure which involves 111 symmetrical muscle strips are formed by 77 pairs of dorsal muscle slips which include psoas, 11 pairs each of internal oblique, external oblique and transversus abdominis; 1 pair each representing rectus abdominis and 5 lumbar vertebrae which are linked by intervertebral joints.[9] In OA patients, some of these muscles don't have the capacity to work properly since no closed intra-abdominal space was seen in which IAP increment could be provided during coughing and straining. Application of NPT in conjunction with ABRA to OA patient by providing abdominal domain may partially throws the merit of some of the necessary increase in the increment of IAP during coughing and straining. Decrease in bowel oedema, removal of cytokine-rich peritoneal fluid, improvement in granulation tissue formation and reducing the heat and fluid loss are the key elements for NPT in the management of septic OA patients.[12-15] It

has been elucidated that the granulation tissue a formation is better with cyclic application of NPT and thereby increasing the rate of cell division and proangiogenic growth factors.[12]

When NPT was combined with the various protocols allowing re-approximation of the fascial edges, high closure rates can be attained successfully.[16] Use of mesh-mediated fascial traction methods may be more valuable in non-infected OA patients but ABRA might be used in the severely infected OA patients in adjunct with NPT.[17] Dynamic traction adjusted continuously with ABRA in combination with NPT mostly prevents fascial retraction and demands improvement in granulation tissue formation, allowing expansion and retraction during spontaneous respiratory cycle.[3,4,18] The stoma-related complications are much more common following OA management.[19] In order to provide effective patient care, some small thoughts which can solve the bigger confusions in this area were come into place for a whole and better understanding of the procedure.[20] The increment in IAP might be attributed to the effectiveness of pulmonary physiotherapy and more powerful straining for starting defecation and all of these can unmatchably contribute for the patient care in OA conditions,. A paradigm shift in the management of OA with NPT in conjunction with ABRA is one of the anchoring points in coughing and straining of OA patient.[21] This study is also not devoid of any limitations and are hence the limitations in this study are only those OA patients who are extubated and oriented with more than 10 cm width OA wound are limitedly found and we get recurrent IAP measurements from the same patient at different times in future.

CONCLUSION

Nowadays the use of OA has gained a huge interest and acceptance that this therapeutic option in critically ill patients with severe intraabdominal pathologies. The most common indications for OA are abdominal trauma, peritonitis, acute pancreatitis and ACS.

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Source of Support: Nil. **Conflict of Interest:** None Declared.

Cite this article as: Y Karthik, Srinivasulu Bandam. Evaluation of Intra-Abdominal Pressure Monitoring in Open Abdomen Management with Dynamic Abdominal Closure: An Institutional Based Study). Int J Med Res Prof. 2018 Jan; 4(1): 689-92.
DOI:10.21276/ijmrp.2018.4.1.154