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REVIEW ARTICLE

Standardized addendums to reporting in neonatal and pediatric minimal access surgery

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Abstract

Minimal access surgeries (MAS) in children and neonates have proven to be safe and effective. Recent advances in technology have significantly contributed to this. However, currently, there is no standardized documentation of minimally access surgery (MAS) in pediatric or neonatal age group. Multiple experimental studies have reported hemodynamic changes taking place in this rather vulnerable cohort many of which are not completely understood. It is important that a standardized reporting tool for accurate documentation of pediatric and neonatal MAS is well overdue. The introduction of such a system will allow for accurate recording of procedures by documenting several variables and facilitate comparisons of various pediatric and MAS procedures between individual centers and institutions.

Keywords Minimal access surgery · Laparoscopy · Thoracoscopy · Systematic reporting · Pediatrics

Introduction

Minimal access surgery (MAS) has been considered as one of the major advances in the field of surgery, further with its safe and systematic introduction in the pediatric and even in the neonatal age group [1–5]. Significant developments in MAS for the adult population in the past few decades have led to increased utilization of MAS in children leading to traditional operations being performed laparoscopically and thoracoscopically and most studies have confirmed their safety and efficacy in children and neonates [1–5]. These advancements have also brought a major transformation in the use of digital and robotic technology in surgical practice with better outcomes in many areas when compared to open procedures [6, 7].

It is vital that safety of this vulnerable cohort of patients is ensured during MAS to sustain good outcomes [2–5]. The main areas of concern reported by several studies revolve around the utility and safety of these procedures, especially in neonates with predisposed conditions and associated comorbidities, coupled with their altered cardiorespiratory response to carbon dioxide (CO_2) insufflation [8–13]. Concerns have also been raised on the effects over uninvestigated areas of metabolism [13]. Besides this, endoscopic surgical procedures utilize multiple energy devices which can alter gas insufflation dynamics. Currently, there are no standardized tool for reporting of MAS in pediatric and neonatal age. Culture of safety is essential during pediatric and neonatal MAS and standardization of care can help surgeons detect and address problems early and improve the quality of care [14]. The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) that caused COVID-19 placed every aspect of endoscopic surgery under scrutiny and set the precedence for accurate documentation of procedures leading to new healthcare pathways allowing appropriate use MAS in children [15–18]. The aim of this review was to establish an urgent requirement for utilization of standardized documentation of MAS procedures in the pediatric age group.

It has been shown previously that nearly two thirds of abdominal operations in pediatric age group can be performed via MAS outlining the feasibility of these techniques [19] and studies have also confirmed that prior open abdominal or thoracic surgery had little impact on the feasibility of abdominal or thoracic MAS for children [20, 21].

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The aim of this review was to elaborate on some of the potentially important factors and variables in pediatric and neonatal MAS and the effects they have on the physiology of neonates and children. Special emphasis has been placed on the abdominal and thoracic insufflation with carbon dioxide and its effects on cardiorespiratory, splanchnic, and cerebral perfusion in children and neonates, as well as effects on metabolism. Technical issues like the port sites and energy sources utilized are also analyzed with an emphasis on the need for utilization as part of the standardized tool reporting tool in neonatal and pediatric MAS. There is increasing demand for accurate surgical documentation of these basic facts during pediatric and neonatal MAS.

The appropriateness of documentation starts with the commencement of the procedure and the positioning of the patient [4, 22]. Changes in position of the patient instigated during an ongoing procedure also need to be documented as insufflation pressures affect the organ perfusion dynamics with these shifts.

Port placements

The technique of primary port and work port placements is important, whereas the primary port placement may vary between open and closed approaches, work ports present with an array of varying sleeve configurations and are coupled with trocars that may be sharp or blunt tipped. Fixation of primary port is not often documented unless a balloon port has been used. In neonatal surgery, securing the ports is a major issue and it is important to record the technique of fixation. Like the entry of ports, removal of ports and the closure of port sites should be part of the documentation. Port site hernia complications in conventional laparoscopy and pediatric robotic surgery ranges from 0.83 to 3.2% and have been observed even with the use of 3 mm ports, depending on the technique of port site closure [23, 24]. This information will be important if there is increase in incidence that may necessitate an audit or service evaluation.

Port site leaks that are frequently responsible for flow rate adjustments are best managed by rectifying the cause, however often during critical stages of the procedures are managed by increased flow rates to minimize disruption and rearrangement of the entire set-up. The use of humidified gas as well as filters, if used, should be included with the insufflation parameters. Documentation should also include the scope size and the angle of view.

Electrosurgical and suction irrigation systems

Multiple range of available electrosurgical energy devices have created a revolution in MAS [25, 26], and electrosurgical devices using manual setting modes require recording of their settings. Records are not required when automated devices are used. However, with monopolar and bipolar energy sources, it should be mandatory to note the original settings and any alterations that are undertaken during the procedure. Malfunction in electrical devices and any replacements made during the procedure need to be documented. Injuries due to malfunctioning electrical devices may often not be evident during the time of surgery but may appear in the early postoperative period. Suction and irrigation if performed should record the amount of fluid utilized and the temperatures of the irrigation fluid if applicable.

Effects of CO_2 pneumoperitoneum

Cardiorespiratory dynamics

Abdominal insufflation results in reduced cardiac output with rise in peripheral vascular resistance, but studies have shown that healthy children tolerated these hemodynamic changes very well without any untoward effects [27]. Gentili et al. have studied cardiac changes with echocardiography and suggest that pneumoperitoneum affects both preload and afterload, while systolic cardiac performance remains unchanged [12]. In their study of children undergoing laparoscopic fundoplication, Rowney et al. have concluded that children tolerated these procedures well with minimal analgesic use and without the need for admission to high dependency care units [4]. Other studies have confirmed safety of low-pressure pneumoperitoneum utilizing, with the use of pressures less than 5 mm hg [8]. Based on these reports, it can be stated that the insufflation pressures, flow rates, total volume of gas and necessary adjustments during MAS along with any changes in cardiorespiratory dynamics should be carefully recorded.

Splanchnic perfusion

Experimental animal studies have shown reduced perfusion and metabolism in small intestine of animals with surgically induced pneumoperitoneum resulting in oxidative stress [13, 29]. These authors recommend close intraoperative monitoring in these young patients. Others conclude that intra-abdominal pressure (IAP) should be below 10 mm Hg to avoid disturbances in splanchnic microperfusion [8–11]. Renal hypoxia and oliguria may also be avoided at lower IAP [30].

Effects on cerebral oxygenation

Pelizzo et al. studied the effects of CO_2 pneumoperitoneum on brain oxygenation and conclude that CO_2 insufflation results in reduced oxygen saturation in the brain. These authors state that this can be reversed by reducing IAP [31]. De vaal et al. have demonstrated that CO_2 insufflation even at low pressures of 8 mm Hg, considerable changes in cerebral blood flow occurs and advise hyperventilation to counteract these effects [28].

CO_2 elimination

Carbon dioxide elimination during laparoscopy in children is age dependent and it has been shown that younger infants absorb more CO2 than their older counterparts. Close monitoring is therefore advisable in small infants undergoing MAS [32].

Endocrine and metabolic responses to CO_2 insufflation

Bozkurt et al., compared the endocrine and metabolic changes during acute emergency abdominal surgery performed using either open or MAS techniques in children. They noted similar changes in both open and MAS groups but slightly increased respiratory acidosis in MAS group [33].

Neonatal MAS procedures

Another aspect that demands detailed and accurate surgical records is neonatal endoscopic procedures, where the complete extent of metabolic changes during surgery is still under investigated [9, 10, 34, 35]. Furthermore, endoscopic surgery in preterm infants is now popular for numerous index cases, with these patients presenting equal challenges for the surgical teams, anesthetists, and intensive care teams in managing patients with immature organ systems that have undergone a dynamic surgery [9, 10, 34, 35]

Though the incisions may be small, MAS is a major procedure from the surgical as well as hemodynamic point of view in preterm neonates and this patient population is very sensitive to CO_2 insufflation, with this issue being a key factor for MAS in this group [9, 10]. Experimental studies by Metzelder et al. found that prolonged CO_2 insufflation induced hypotension and cardiac depression in newborn pigs but not in adolescent pigs [9]. Kalfa et al. have noted prolonged operative times, preoperative hypothermia, thoracoscopy and need for increasing oxygen and fluid expansions influenced intraoperative course [34]. Other studies have confirmed profound effect on neonatal cardiorespiratory hemodynamics and suggest that the IAP should be limited in neonates undergoing MAS and suggest adequate preparation and constant intraoperative monitoring to ensure safe anesthesia during neonatal MAS [35]. Appropriate case selection is necessary in neonates to achieve maximal safety in neonatal MAS [34, 35]. Reviewing commonly performed thoracic procedures for neonates, Tobias concluded that anesthesia for neonatal thoracoscopy is safe and feasible [36].

Desiccation of the peritoneum

Ott believes that introduction of cold and dry gas like CO_2 during laparoscopy can result in drying of tissues which he termed “desertification of peritoneum” which can be prevented by prewarming and humidification of the CO2 [37]. Clinical trials have studied the effects of warmed and humidified carbon dioxide on patients after laparoscopic procedures and confirmed significantly lower hypothermia, reduced pain, and decreased need for analgesics [38]. Temperature and humidification of CO_2 should be recorded, and any variation needed during MAS to be accurately documented.

Effects of the Coronavirus disease 2019 (COVID-19) pandemic

Highlighting some of the above basics that should be part of surgical documentation, it is important to bear in mind that the population worldwide is still being affected by the pandemic. Globally, there has been an unprecedented impact on pediatric surgical services by the COVID-19 pandemic and studies have shown that every aspect of the surgical profession has been changed on an unprecedented scale [15]. It is essential that knowledge and lessons learnt need to be shared to maintain the highest standards of professional care are available to children as we sail through this unforeseen storm [15]. Better understanding of spread, the risk of asymptomatic carriage in children, and the reliability of testing have led to development of the novel care pathways and allowed appropriate use of open and MAS during the pandemic [16–18]. Conflicting views regarding the presence of the virus in abdominal tissues and fluids have been debated widely and no studies have supported the hypothesis that Severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) can be aerosolized and transmitted through surgical smoke [39]. With appropriate protective measures, MAS is safe for patients and staff during the COVID-19 pandemic and continues to have advantages compared with open surgery [16–18]. As experience is gained in management of surgical patients in the post-pandemic era, protocol-based management can be very effective and easily revised as needed based on the evolving scientific evidence [16–18, 40–46]. The proposed standardized reporting for Neonatal/Pediatric MAS in addition to the operation notes is comprehended in Table 1.

Conclusion

There is an ever-increasing utilization of MAS in pediatric and neonatal population. Detailed and accurate surgical documentation especially preterm neonates and those

Table 1 Proposed standardized reporting chart for Neonatal/Pediatric MAS in addition to the operation notes

Variables	Intraoperative changes	Yes/no	Reason for change
Camera size and type	Change of camera Shift to different port site		
Instrument length	Need to change		
Insufflation pressure (mm Hg)	Increase or decrease in pressure		If Yes, changes to () mm Hg -Duration? -Reason-anesthetic/surgical
CO_2 humidified and pre warmed	Temperature Humidification		
Flow rate	Increase or decrease in flow		If Yes, changes to () mm Hg Duration? Reason-anesthetic/surgical
Operative duration (minutes)	Expected time completion		If no, reason
Conversion	Anesthetic concerns? Surgical concerns?		Reason? Reason?
Complications Yes/no			What complication? How dealt?
Ports used (total)	Additional ports needed (*adhoc* additional ports)?		If yes, how many?
Port sites positioning	Additional port sites used (*adhoc* intraoperative)?		If yes, where?
Port site leaks	Intervention needed?		If yes –change of ports/valves/ suture fixation? Other?
Energy devices type and settings	Need for additional energy sources		If yes, state other source- reason?
Additional equipment utilized			If yes, specify
Patient position	Changes during procedure		If yes, new position and duration? Reason -anesthetic? Surgical?
Heart rate alterations	Any intervention needed?		If yes, specify
Respiratory rate changes	Any intervention needed?		If yes, specify
O_2 saturation changes	Any intervention needed?		If yes, specify
Temperature alterations	Any intervention needed?		If yes, specify

with associated comorbidities are paramount. There is an urgent need for standardized reporting tool for pediatric and neonatal MAS. Standardized reporting will help in further research in understanding of intraoperative and postoperative responses of these vulnerable cohort of patients to MAS besides allowing for meaningful comparisons between procedures, surgeons and institutions alike.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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