Short Report

Stranded in the web of evidence and ethics

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Natural Orifice Translumenal Endoscopic Surgery (NOTES) is the execution of a diagnostic or therapeutic intervention within the peritoneal cavity with flexible endoscope, which is passed through a natural orifice. NOTES earned its nomenclature and worldwide recognition following trans gastric liver biopsy in a porcine model by Kalloo et al. in 2004.[1] It is generally regarded as 3rd generation surgery, which has the potential to replace current modes of surgical treatment. The technical feasibility of NOTES is proven in animals after scores of procedures through trans gastric, trans vaginal, trans colonic and trans vesical routes: cholecystectomy,[2] appendectomy,[3] splenectomy[4] bowel resection-anastamosis,[5] gastrojejunostomy[6] and tubal ligation.[7] These surgical landmarks have prompted NOTES enthusiasts to conduct several operations in humans: appendectomy,[8] peritoneoscopy[9,10] and cholecystectomy.[11] There is no consensus on the best route of access to the abdominal cavity. The trans gastric approach seems to be very popular in spite of difficulty in recognition of retroflexed organs in the upper abdomen. Currently, NOTES depends on technology "borrowed" from flexible endoscopy. The endoscopic accessories are primarily meant for intra luminal use. They are not robust enough to facilitate triangulation and elevation of tissues, which are vital to resection-anastamosis during conventional and laparoscopic surgery. Flexibility of the shaft of endoscope is a major drawback within large space of the peritoneal cavity. The tip control is poor and access to the desired location within the abdomen is compromised. Viscerotomy is usually sealed with haemoclips, which appose only the mucosal lining and do not extend to the muscle layer. The aforementioned limitations have delayed the clinical application of NOTES. High grade NOTES surgery is regarded as technically demanding and risky at present. On the other hand, there is enough enthusiasm to resolve these problems by developing high resolution endoscopes and suitable accessories for transluminal surgery. Some of the examples include R scope, Cobra scope, Transport scope, Eagle claw, Shape lock, stable platform and robust graspers for holding tissues (Figure). New techniques for endoscopic suturing are devised. T bars, star anchors and remotely controlled mini robots have been successfully deployed for access closure.[12-16] By virtue of these advancements since 2004,

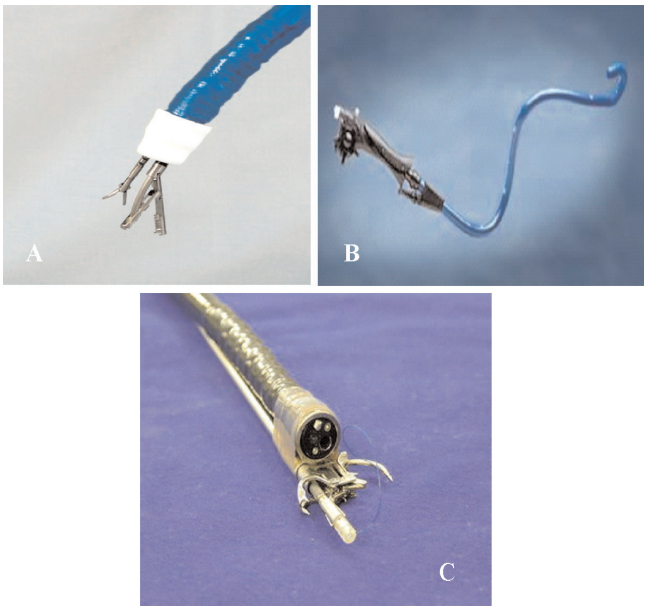

Figure: Modern endoscopy equipment for NOTES (A) Robust grasper (B) Shape lock and (C) Eagle's claw.

NOTES has in fact rendered a favourable impact on gastrointesinal endoscopy. Natural Orifice Surgery Consortium for Assessment and Reasearch (NOSCAR) have allocated massive grants for research on NOTES issues, pertaining to infection, anastamotic leaks, post operative adhesions and alteration in immunophysiology.[17] NOTES proponents are keen to see its early clinical application in cases admitted to intensive care units (ICUs). The hazards of positive pressure breathing such as atrophy of the diaphragm, pneumothorax and decreased venous return can be eliminated by trans gastric endoscopic placement of a diaphragm pacing system.[18] Most of the ICU patients die of abdominal sepsis and mesenteric vascular insufficiency. These entities can be conveniently diagnosed by trans gastric flexible peritoneoscopy without mobilizing the patient for contrast enhanced computed tomography scan. Bedside laparoscopy is more cumbersome in such cases. On the spot NOTES surgery is expected to become a reality in the near future for victims of road accidents,[19,20] earthquakes and blast injuries. Visceral perforation, which was previously described as the most feared complication of flexible endoscopy, can now be sealed by NOTES intervention. Transluminal surgery is a viable option for repair of anastamotic leaks and intra abdominal fistulas. NOTES is also planned to be incorporated into joint ventures with other disciplines like gynaecology, cardiothoracic surgery and neurosurgery. Incidental removal of a stone laden gallbladder and inflamed appendix is feasible during trans vaginal hysterectomy. It is possible to drain refractory pericardial effusion into the peritoneal cavity by creation of a pericardioperitoneal window through trans vesical access.[21] Intractable visceral pain can be similarly managed by administration of nerve block by transluminal route. Most of these tasks are achievable by natural orifice surgery, which offers several advantages. NOTES eliminates general anaesthesia, abdominal incisions, post operative adhesions, scarring, incisional hernias and the use of peri operative medication for pain and infection. It shortens length of stay in the hospital, reduces burden of surgery and decreases the cost of intervention. These potential benefits undoubtedly reflect superiority of NOTES over laparoscopic and conventional surgery.

Notwithstanding the stir created by transluminal surgery, NOTES has also invited abundant criticism. There is prevailing mistrust about the technical feasibility and safety of NOTES for high grade interventions. There are serious questions about the risk of intra abdominal infection after surgery through a natural orifice. The researchers are reluctant to promote NOTES on account of lack of medical evidence and ethical justification for an allegedly hazardous form of surgery.[22,23] However, only some of these concerns sound genuine, at least for the time being. The urgent treatment of intra operative complications like bleeding and perforation has attracted special attention of the critics. We believe that most of the technical "hiccups" and safety issues will be solved with the development of new instruments and more research work. Ravens et al have recently concluded that accidental bleeding during NOTES procedure can be effectively treated with forced argon plasma coagulation. The outcome of haemostasis is determined by the size of bleeding vessel and its location within or outside the wall of the viscus.[24] This animal study is pertinent in warding off some queries regarding expertise of the operator and application of new endoscopic methods to deal with NOTES related iatrogenic emergency. Hazey et al. conducted a study about the bacterial contamination of peritoneal cavity during conventional gastrojejunostomy in patients.[10] The intraoperative cultures of gastric juice and peritoneal fluid demonstrate limited growth of microorganisms. Most of these strains are clinically insignificant. The microbial growth is more pronounced in patients receiving proton pump inhibitors.[25] We support this view point in the light of our NOTES experience in animals. Following trans gastric flexible peritoneoscopy in 23 animals, there was no evidence of infection in 18 successful cases wherein percutaneous endoscopic gastrostomy (PEG) technique was used for viscerotomy. No antibiotics were given perioperatively. The visceral aperture was easily created after "pre dilatation" of the primary tract. Gastrotomy was sealed with haemoclips. We observed that the closure of gastrotomy with haemoclips was adequately secure. However, we used parenteral

antibiotics for 3-5 days in 2 clinical NOTES procedures: trans gastric flexible peritoneoscopy and endoscopic incision drainage of an indenting pseudocyst of the pancreas. In view of an uneventful recovery in both cases, we are not sure if at all the short term use of antibiotics was really justified. In our opinion, mere translocation of bacteria is not enough to cause post operative infection. It is similar to general perception about the spillage and translocation of malignant cells during cancer surgery. It is very likely that the distant spread actually results from micro metastases, which occur long before the surgical removal of a tumour. The interaction of several unexplored factors seems mandatory in both infection and tumour kinetics. Trans sphenoidal hypophysectomy is the classical example of a time tested natural orifice surgery. This operation would have been long abandoned had translocation of the nasal flora caused frequent intracranial infection. The results of field surgery are very encouraging despite inadequate sterilization. These examples augment our hypothesis that the risk of infection after surgical or endoscopic intervention is widely exaggerated. No surgery can be performed without violating the sterility of internal environment. So, why single out NOTES?

Transluminal intervention requires paradoxical creation of visceral perforation. This idea is generally perceived by the critics as unethical particularly when applied in patients. The opponents of NOTES consider viscerotomy as serious violation of the basic principle of surgery. This is an important reason for the lack of clinical evidence in support of NOTES. The fact remains that medical research has sometimes made crucial progress when the dogma was challenged. Undue and protracted criticism has often deprived patients of the benefits of a new treatment modality for many years. "Experimentation" on animals cannot go on for ever. Animal study merely determines the feasibility of a method whereas "learning" on humans is vital to assess its safety and efficacy. We need to recall that the organ transplantation (when immunosuppression was still primitive), Whipples' pancraeticoduodenectomy and long term hazards of thalidomide or radiation were all "learnt" on patients and human volunteers. Similarly, the "consensus statements" for treatment of hepatitis B and C are still renewed without arriving at a lasting conclusion. Thus concrete medical evidence cannot be gathered without conducting "clinical trials" and "learning" on humans. Albert Einstein, the German Physicist, once stated that imagination was more important than knowledge. According to our assessment, the concept of NOTES has existed inadvertently since the middle of the 20th century and Bueno seems to be the true initiator of NOTES. He performed the first transvaginal appendectomy in 1949.[26] Reiner reproduced this operation in 1980 in 100 patients. Tsin et al. carried out transvaginal cholecystectomy and termed the procedure as "culdolaparoscopy".[27] NOTES was also practiced during early 80s by surgical innovators under the title of "transanal endoscopic microsurgery" (TEM).[28] Pomp et al. removed a large hepatic adenoma through posterior colpotomy.[29] In spite of having come so frequently close to developing a new surgical technique, NOTES remained elusive for almost half a century due to a restrictive approach of the researchers and ethical committees. The criticism continues unabated. Pomp et al. suggested that NOTES should be relegated to laboratory experimentation pending availability of proper instruments.[29] It was however, maintained that violation of the integrity of one organ for the treatment of disease in another organ was unethical. We do not consider this argument convincing because (extended) TEM per se involves surgical resection of the prostate by transanal access. TEM is also used for the treatment of lesions at the rectosigmoid junction, which necessitates violation of the peritoneal cavity. This operation apparently facilitates translocation of faecal flora into the peritoneal cavity. There is no justification in vaginal route as ethically acceptable for removal of the gall bladder by NOTES method. Similarly, there is little explanation as to why should a loop of the small bowel be permanently sutured with the stomach to reroute gastric contents. The current reluctance to accept NOTES is no different from the treatment meted out to laparoscopic surgery. Pneumoperitoneum was created in a canine model in 1901. However, the first laparoscopic cholecystectomy by Erich Muhe in 1985 earned strong rejection by the German Society of Surgeons. Had the French gynecologist Mouret not grabbed this opportunity in 1987,[22] laparoscopic surgery would have been a fantasy until today.

Strictly speaking, the lumen of a hollow viscus is bounded by mucosa. The creation of viscerotomy for NOTES mandates full thickness penetration inclusive of the peritoneal covering. Thus NOTES should be more appropriately renamed as "transvisceral" surgery. An endoscopic intervention should be called as "transluminal" if the depth of penetration does not extend beyond serosa e.g. submucosal resection (SMR) and endoscopic submucsal dissection (ESD). We earnestly feel that laparoscopic guidance for NOTES surgery (i.e. hybrid NOTES) holds key for the training of future "endoscopic surgeons".[30] Routine practice of hybrid NOTES on the pattern of trans umbilical endoscopic surgery (TUES)[31] and "invisible cholecystectomy"[32] will reduce both cost and burden of surgery pending popularization of "pure NOTES" in humans. It is pertinent to quote Arthur C Kline that limits of the possible can be defined only by going beyond them into the impossible.[33]

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