Introduction

For about two decades, thoracic surgical approach has taken a decisive turn with videoscopy introduction in cardiac and non-cardiac thoracic surgery. This thriving technique becomes gradually a reference technique in thoracic surgical approach and is a minimally invasive approach to the thorax with minimal post-operative pain, reduction of the duration of hospitalization and a post anaesthetic procedures. However, this thoracic approach requires a specific technical and ancillary material that limits diffusion in developing countries. Chest surgical approaches are surgical accesses to the chest and its content. Two major groups of chest approaches are described: conventional or classic and minimally invasive" surgical approaches [(1)]. The conventional surgical approaches are anterior approaches [(2)] such as the vertical median sternotomy, the Chamber-lain anterior mediastinotomy, the anterolateral thoracotomy, the partial Sternotomy with anterolateral thoracotomy "Hemiclamshell", the bilateral transverse Sterno-thoracotomy "clamshell"; the side approaches [(3)] such as the lateral thoracotomy, and postero-lateral approaches [(3)]. "Minimally invasive" [(1)] chest approach tracts involve direct thoracoscopy, video-assisted thoracospic surgery, video-assisted thoracic surgery, video-assisted in conventional surgery, minimally invasive cardiac surgery assisted by video-assisted thorascopic surgery, approaches tracts for diagnostic biopsies (the "traditional" mediastinoscopy; video mediastinoscopy) and robotics [(4)]. This study aims to report indications of chest surgical approach tracts performed in Cote d'Ivoire and post-operative results.

Methods

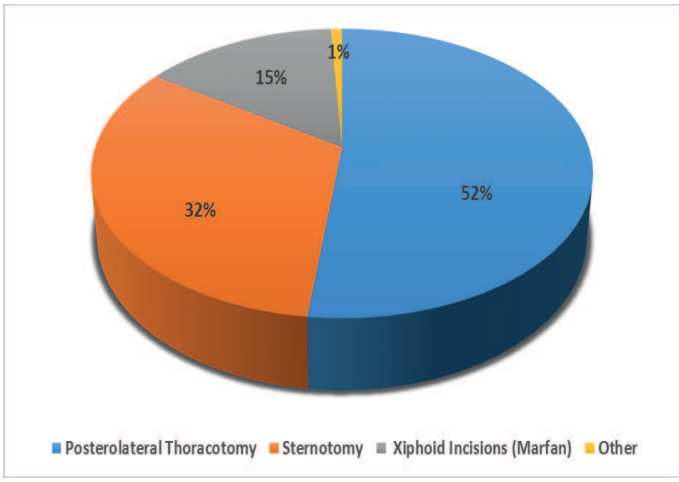
Using the 1998 and 2014 nationwide inpatient database, we identified retrospectively, 814 patients including 475 men and 339 women who underwent a cardiothoracic surgery. Mean age was 32.73 years; range was: 2 months - 88 years. Postoperative pain was treated according to two different protocols depending on the ladder of the WHO analgesic activity scale [5] Protocol 1 begins with the WHO analgesic ladder III (ladder 3) i.e. intravenously injected morphine by syringe pump at a dose of 0.3 mg·kg-1·d-1 from D0-D3 postoperative then nefopam by slow intravenous injection at a dose of 20 mg x 4. D-1 associated with paracetamol intravenously at a dose of 1g x 4.d-1 from post-operative D4-D6; then an oral treatment with paracetamol associated with codeine (500/30mg) at a dose of 1capsule x 3.d-1 or by tramadol 50 mg at a dose of 1 capsule x 2/day, from D6 to discharge. Protocol 2 begins with the WHO analgesic ladder II (ladder 2) i.e. neoplasm by slow intravenous injection at a dose of 20 mg x 4. D-1 associated with intravenously injected paracetamol at a dose of 1g x 4.d-1 from postoperative D0-D4; then an oral treatment with paracetamol associated with codeine (500/30 mg) at a dose of x 1capsule 3.d-1 or 50 mg of tramadol at a dosage of 1 capsule 2 x/d, from D4 to the exit. No epidural analgesia or intercostal nerve block was used. Chest tubes were set in continuous aspiration to -25 mmHg except in case of pneumonectomy. Chest surgical approaches performed, their indications, post-operative results regarding intensity of post-operative pain assessed by analgesic protocol used, length of stay, time of healing and the appearance of the postoperative scar had been studied.

Results

Eight hundred and fourteen (814) chest surgical approaches were performed (Fig.1), including 422 (51.84%) classic posterolateral thoracotomies, 265 (32.55%) vertical median sternotomies, 120 (14.74%) xiphoid incisions for pericardial drainage by Marfan retro-xiphoid approach and 7 (0.85%) other thoracic surgical approaches. These chest approaches were used either for Cardiac Surgery (n = 473; 58.10%) or for non-cardiac chest surgery (n = 341; 41.89%). In Cardiac Surgery, 250 (52.85%) vertical median sternotomies, 101 (21.35%) posterolateral thoracotomies, 120 (25.36%) xiphoid incisions and 2 (0.42%) video-aided thorascopic surgery were performed (Fig.2).

The vertical median sternotomy was indicated for surgical correction of 87 (18.39%) valve diseases, 121 (25.58%) congenital heart disease, and other 42 (8.87%) acquired heart diseases. All pericardial drainages (N = 120; 25.36%) were performed by a classic xiphoid incision according to MARFAN retro-xiphoid approach. The classic postero-lateral thoraco-tomy was prescribed for the correction of 98 (20.71%) congenital heart disease and 3 (0.63%) surgical explorations for post-operative bleeding. Video-assisted thoracoscopy was prescribed 2 times (0.42%) for ductus arteriosus closure by clips. In non-cardiac thoracic surgery, 321 (94.13%) posterolateral thoracotomies, 15 (4.39%) vertical median sternotomies (1.46%) and 5 (1.46%) other surgical approaches were done (Fig.2). The postero-lateral thoracotomy technique was prescribed for the surgical treatment of 121 (35.48%) pleural diseases, 133 (39.00%) diseases, 19 (5.57%) mediastinal disorders, 34 (9.97%) parietal diseases, and 14 (4.10%) other non-cardiac chest diseases. Conventional vertical median sternotomy was prescribed for the surgical treatment of 7 (2.05%) and mediastinal disorders and 8 (2.34%) parietal conditions. The previous Chamberlain media-stinotomy (n = 2; 0.58%), and mediastino-scopy (n = 3; 0.87%) were prescribed to carry out mediastinal tumor biopsies. The intensity of postoperative pain after the vertical median sternotomy and posterolateral thoracotomy (n = 687; 84.39%) was sharp and required the administration of morphine by injection (WHO analgesic ladder 3), while minimally invasive approaches such as Chamberlain anterior mediastinotomy, media-stinoscopy and video-assisted thoracoscopy were less painful and required the admini-stration of tramadol by injection (analgesic WHO ladder 2) (Table I) . The hospital stay was 5.25 days (4-7 days) for vertical median sternotomy, 13.68 days (3-31 days) for posterolateral thoracotomy, 9.37 days (4-14 days) xiphoid incisions and 3.5 days (2-4 days) for minimally invasive approaches such as Chamberlain anterior mediastinotomy, mediastinoscopy and video-assisted thoracoscopy (Table I).

The hospital varied depending on the type of surgical procedure performed (Table II and III). Healing time was 22.25 days (17-30 days) for vertical median sternotomies, 27.69 days (13-60 days) for posterolateral thoracotomies, 17.5 days (10-20 days) for xiphoid incisions with a highly visible and unsightly scar while it was 7.5 days (6-10 days) for minimally invasive approaches such as Chamberlain anterior mediastinotomy, mediastinoscopy and video-assisted thoracoscopy with a less visible and anaesthetic scar.



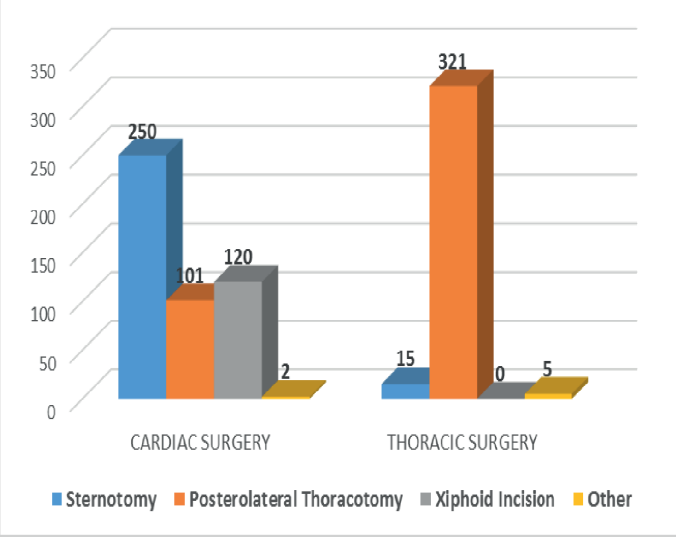


Table I: Postoperative results according to chest approach

Approaches	Postoperative pain treatment	Hospital stay length : days Average (extreme)	Postoperative disorders (%)	Cicatrization duration (days)
Vertical median sternotomy N=265	Morphine (48h) + tramadol +/- nefopam (5 days)	5.25 (4-7)	0	22.25 (17-30)
Posterolateral thoracotomy N=422	Morphine (48h) + tramadol +/- nefopam (5 days)	13.68 (3-31)	6.3	27.69 (13-60)
Xiphoid incision N=120	Tramadol +/- nefopam (4-5 days)	9.37 (4-14)	1.3	17.5 (10-20)
Others (videothoracoscopy, mediastinoscopy, chamberlain mediastinotomy) n=7	Tramadol +/- nefopam (48h) Tramadol +/- nefopam (48h)	3.5 (2-4)	0	7.5 (6-10)

Table II: Postoperative results according to procedure in Cardiac Surgery

Procedures	Hospital stay length : days Average (extreme)	Postoperative pain treatment	Postoperative disorders (%)	Cicatrization duration (days)
STERNOTOMY				
Valvular surgery	9 (8-10)	Morphine (48H) + Tramadol +/- Nefopam (5 Days)	0	13, 50 (7-20)
Pericardiectomy	10.5 (8-13)			
ASD/VSD repair	8.5 (3-13)			
Cure of AVSD	6.5 (6-7)			
Tetralogy of Fallot repair	8.35 (5-21)			
pulmonary stenosis repair	11 (8-14)			
POSTEROLATERAL THORACOTOMY				
Open PDA closure	5.73 (4-9)	Morphine (48H) + Tramadol +/- Nefopam (5 Days)	0	10.5 (8-14)
Modified Blalock Operation	5.6 (5-6)			
Aorta coarctation repair	7			
INCISION XIPHOIDIENNE				
Pericardial drainage	**9.37** (4-14)	Tramadol +/- Nefopam (4-5 Days)	1.3	**17.5** (10-20)
OTHER (VIDEO-THORACOSCOPY)				
PDA closure by VIDEO	**3.5** (3-4)	Tramadol +/- Nefopam (4-5 Days)	0	8 (7-10)

Table III: Postoperative results according to non-chest cardiac procedures

indications	Hospital stay length : days Average (extreme)	Postoperative pain treatment	Postoperative disorders (%)	Cicatrization duration (days)
POSTEROLATERAL THORACOTOMY				
Empyemectomy / pleurectomy	10.04 (5-31)	Morphine (48H) + Tramadol +/- Nefopam (5 days)	6.3	27.69 (13-60)
Mechanic and chemical pleurodesis	9.57 (4-15)			
Pneumonectomy/Lobectomy	11.5 (6-30)			
Bullectomy	7			
Bronchotomy	6.6 (6-8)			
Tumoral biopsy	3.5 (3-5)			
Tumorectomy	7.66 (7-8)			
Diaphragmatic repair	8.5 (4-17)			
Exploratory Thoracotomy for Post traumatic hemothorax	7.66 (3-14)			
STERNOTOMY				
Tumorectomy	7.66 (7-8)	Morphine (48H) + Tramadol +/- Nefopam (5 days)	0	13.50 (7-20)
OTHERS Mediastinoscopy/ Mediastinotomy				
Mediastinal Tumor biopsy	2	Tramadol +/- Nefopam (24 H)	0	7 (6-10)

Discussion

Cardiac and non-cardiac thoracic surgery in Cote d'Ivoire is carried out mainly through traditional surgical approaches. Minimally invasive thoracic surgical approaches are almost non-existent. This situation is contrary to that of the developed countries where the minimally invasive thoracic surgery and minimally invasive cardiac surgery are gro-wing for over 15 years [6]. According to Jougon and colleagues [2], previous chest surgical approaches are the preferred approaches for mediastinal surgery, cardiac surgery, and pulmonary and cardiopulmonary transplan-tations while the posterolateral thoracotomy has always been considered as the preferred approach for lung surgery. For cardiac surgery, we have addressed all valvular diseases acquired by vertical median sternotomy to carry out a valve replacement or a valvular plasty. Our practice was different from Obadia J-F's [7; 8] in France in 2006 and 2010. He has used video-assisted thorascopy to carry out valve replacement, even complex valvular plasties, and tumor resections. As for American authors like Alexander Iribane [9; 10]; they extend the prescriptions for minimally invasive cardiothoracic surgery to repairs or replacements of the aortic valve, to the repair or replacement of the mitral valve, and to aortocoronary bypass. According to literature [8; 10; 11; 12], the minimally invasive mitral valve surgery is the most performed practice of the minimally invasive cardiothoracic surgery. Regarding congenital heart diseases, they were addressed either through a sternotomy or through a conventional posterolateral thoracotomy, except 2 (0.42%) cases of arterial channels that were addressed by video-assisted thoracoscopy which is below the current trend whereby some congenital heart diseases such as inter-atrial and inter-ventricular communications are operated from a minimally invasive thoracic approach [8; 9; 13; 14; 15].Unlike Hui-Ping Liu [16] in 1994 in China, who proposed a pericardial surgical drainage by video-assisted thoracoscopy in particular for patients with pleural and pericardial effusion,we have realized all pericardial surgical drainages by Marfan retro-xiphoid approach. Regarding the non-cardiac thoracic surgery, the minimally invasive approach is almost nonexistent in our practice because of the lack of suitable equipment and training of the surgical team while according to several authors [17-41] the minimally invasive thoracic surgery remains the technique choice to surgically treat almost all pleural, pulmonary and mediastinal diseases. However, according to Joshua Neto et al [42] in 2014 in Brazil and Thomas Kirby [30] in 1995 in the USA, regardless of the type of surgery, the minimally invasive approaches are used in two forms. In one hand, in a direct form or by mini-thoracotomies or by the technique by muscular savings and in other hand, in an indirect form with the video-assisted performed safely. Intensity and duration of post-operative pains are less important in chest minimally invasive approach versus conven-tional thoracic approach. So, Santambrogio [37] in 1995 in Italy, administered 106 mg of ketorolac versus 143 mg, Ayed [38] in 2000 in Kuwait, used Demerol 75 mg (45-150) versus 150 mg (40-300) and Abdala [35] in 2001 in Spain administered painkillers for 38 hours versus 77 hours. As for Kuhlman [43] in 1999 in France, asserted that given the various backgrounds of pain after thoracic surgery, it is rare that a single technique, even the most sophisticated, brings about a total control of painful manifestations and namely shoulder pains. Also, regardless of the choice of a postoperative local analgesia technique, the association with a parenteral supplement administered on demand should be prescribed systematically. According to V Joshi [44] in England in 2013, Video-Assisted Thoracic Surgery reduces length of hospital stay.

Brevity of hospital stay for minimally invasive thoracic approach versus conventional chest approach was also dealt with by other authors namely Santambrogio [37] in 1995 in Italy, Ayed [38] in 2000 in Kuwait, Abdala [35] in 2001, in Spain. They respectively found it for pulmonary segmentectomy, an average length of 4.6 versus 7.8 days; 3 versus 5 days; 5.3 versus 7.5 days. Other authors like Ayed [31] in 2000 in Kuwait, Waller [33] in 1994 in England and Gebhard [34] in 1996 in Germany, reported hospital stay length as follows in order: 6.5 versus 10.7 days, 4 versus 5 days and 5 versus 7 days for the surgical treatment of pneumothorax (with talc)

by video-assisted Thoracic surgery versus thoracotomy. S for Thomas Kirby [30] in 1995 in the USA, it is 7.1 versus 8.3 days for pulmonary lobectomy by video-assisted thoracic surgery versus thoracotomy. In cardiac surgery, the same observations were made by authors like Lin PJ [45] in 1997 and Murat Basaran [46] in 2008 found respectively hospital stays of 5.1 days versus 8 days and 5.4 days versus 7.2 days for surgical closure of an Inter-Ear Communication by Anterolateral Mini-thoracotomy versus conventional vertical median sternotomy. As for Sung-Ho Jung [47], in 2009, he mentioned a 3.6-day hospital stay versus 6.1 days for surgical closure of an Inter-Ventricular Communication by Antero-lateral thoracotomy versus conventional vertical median mini-sternotomy. Other authors [48, 49, 50] were also unanimous on the fact that minimally invasive approaches decreased post-operative complications, reduced the duration of chest tube and the length of stay in hospital while success of the surgical procedure is comparable to traditional surgical approaches.

Considering these results in literature, the average hospital stay is 9.43 days (range 2-50 days) in our practice remains excessive. The hospital stay in our study was comparable to the length of hospital stay found by other authors for conventional chest approaches while it was too long compared to the minimally invasive approaches with the same authors. Regarding the rate of wound infections to abscesses type of the wound found in 7.6% of cases, our results were comparable to those of Grossi [51] in 1999 who reports an incidence of 5.7% for conventional sternotomy versus 0.9% for the mini-thoracotomy. The cost of minimally invasive approaches remains questionable. Actually according to Swanson SJ [52] in the USA, hospital costs of conventional thoracotomy for lobectomy ($ 21,016) are higher than those of Video-assisted Thoracic Surgery ($ 20,316) for the same intervention (p = 0.027). These results tally with the findings of Casali [53] in 2009, in England, who indicated that the overall cost of Video-assisted Thoracic Surgery for a lobectomy was lower (8023 € ± 565) compared to the cost of a lobectomy (8178 € ± 167) (P = 0.0002) by conventional thoracotomy; and that, due to the reduction in the duration of the patient's postoperative stay in intensive care for Video-assisted Thoracic surgery. The author concludes that the video-assisted Thoracic Surgery for a lobectomy is cheaper than lobectomy by conventional approach; and the increased costs of surgical procedure due to consumables is offset by a shorter hospital stay. Rodriguez E [54] drew the same conclusion in September 2014, in the USA. He found out that the aortic valve replacement by right anterior minimally invasive approach is less expensive than that achieved by conventional median sternotomy ($ 38,769 versus $ 42,656; p <0.01). In our developing countries, this practice of minimally invasive chest approach is possible as it has already been carried out in South Africa [55], Turkey [56] and Brazil [57], but unlike Western countries, in developing countries like ours, the video-assisted Thoracic Surgery is more expensive than the conventional thoracotomy approach because of consumables cost [56, 58]. Thus, the practice of these minimally invasive approaches in our developing countries will require a good strategy for patient selection [58, 59]. However, to start this minimally invasive thoracic approach in our developing countries, the Brazilian model of Cardiac Surgery could be encouraged because it provides direct minimally invasive thoracic without video-assistance and gives satisfactory results [57]. In non-Thoracic Cardiac Surgery, the thoracotomy with Muscular Saving [30] could be recommended because it gives encouraging results. Moreover, as argued by Frank Edwin [60], in 2011, in Ghana; the development of Cardio-Thoracic Surgery seems closely parallel to the country's economic development and patients' ability to honor the cost of this surgery. In our developing countries, health insurance seeing to be an essential condition for the Cardio-Thoracic Surgery and Minimally invasive Cardio-Thoracic Surgery development. Accor-ding to Joshi V [44] in England in 2013, the Video-Assisted Thoracic Surgery has a similar recurrence rate with that of the conventional thoracotomy; it reduces the risk of intra-operative bleeding.

Conclusion

The development of minimally invasive approaches for thoracic and cardiovascular surgery remains a challenge in Cote d'Ivoire. Thoracic approaches being currently used in Cote d'Ivoire are uncomfortable, extend hospitalization and healing time, leave unsightly scars and sometimes turn excessive. Therefore, we need to convert our classical option to a minimally invasive approaches which remains a challenge for us.

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