Material and methods

This is a retrospective study from January 1998 to June 2015 performed at Abidjan Heart Institute and at Cardio-vascular and Chest Diseases Department of the University Hospital of Bouake, on 341 chest-operated patients. The average age was 32.73 (range 2 months - 88 years). The post-operative pain was treated according to two different protocols depending on the ladder of the WHO analgesic activity scale[3] **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. We study the chest surgical approaches performed, their indications, postoperative results regarding intensity of post-operative pain, assessed by analgesic protocol used, length of stay, time of healing and the appearance of the post-operative scar.

Results

In non-cardiac thoracic surgery, 321 (94.13%) postero-lateral thoracotomies, 15 (4.39%) vertical median sternotomies (1.46%) and 5 (1.46%) minimally invasive approaches such as Chamberlain anterior mediastinotomy, mediastinoscopy were performed. The postero-lateral thoracotomy 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%) mediastinal disorders and 8 (2.34%) parietal conditions. The Chamberlain mediastinotomy (n = 2; 0.58%), and mediastinoscopy (n = 3; 0.87%) were prescribed to performed mediastinal tumor biopsies. The intensity of post-operative 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 were less painful and required the administration 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 postero-lateral thoracotomy, and 3.5 days (2-4 days) for minimally

invasive approaches such as Chamberlain anterior mediastinotomy, mediastinoscopy (**Table I**). The Indications and postoperative results depending on the type of surgical procedure performed (**Table II**). Healing time was 22.25 days (17-30 days) for vertical median sternotomies, 27.69 days (13-60 days) for posterolateral thoracotomies, 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 with a less visible and anesthetic scar.

Approaches	Postoperative pain treatment	Hospital stay length : days Average (extreme)	Postoperative disorders (%)	Cicatrization duration (days)
Vertical median sternotomy N=15	Morphine (48h) + tramadol +/- nefopam (5 days)	5.25 (4-7)	0	22.25 (17-30)
Posterolateral thoracotomy N=321	Morphine (48h) + tramadol +/- nefopam (5 days)	13.68 (3-31)	6.3	27.69 (13-60)
Others (mediastinoscopy, chamberlain mediastinotomy) n=5	Tramadol +/- nefopam (48h)	3.5 (2-4)	0	7.5 (6-10)

Table I: Post-operative results according to chest approach

indications	Hospital stay length : days Average (extreme)	Postoperative pain treatment	Postoperative disorders (%)	Cicatrization duration (days)
POSTEROLATERAL THORACOTOMY				
Empyemectomy / pleurectomy	10.04 (5-31)			
Mechanic and chemical pleurodesis	9.57 (4-15)			
Pneumonectomy/Lobectomy	11.5 (6-30)			
Bullectomy	7			
Bronchotomy	6.6 (6-8)	Morphine (48H) + Tramadol +/- Nefopam (5 days)	6.3	27.69 (13-60)
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)

Table II: Indications and post-operative results in general thoracic surgery

Discussion

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 have been growing for over 15 years[4]. 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[5-29] the minimally invasive thoracic surgery remains the technique choice to surgically treat almost all pleuro-pulmonary and mediastinal diseases. However, according to Joshua Neto et al[30] in 2014 in Brazil and Thomas Kirby[18] in 1995 in the USA, regardless of the type of surgery, the minimally invasive approaches are used in two forms. On the one hand, in a direct form

or by mini-thoracotomies or by the technique by muscular savings and on the 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 conventional thoracic approach. So, Santambrogio[25] in 1995 in Italy, administered 106 mg of ketorolac versus 143 mg, Ayed[26] in 2000 in Kuwait, used Demerol 75 mg (45-150) versus 150 mg (40-300) and Abdala[23] in 2001 in Spain administered painkillers for 38 hours versus 77 hours. As for Kuhlman[31] 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 Joshi[32] in England in 2013, the Video-Assisted Thoracic Surgery reduces the length of hospital stay. The brevity of hospital stay for minimally invasive thoracic approach versus conventional chest approach was also dealt with by other authors namely Santambrogio[25] in 1995 in Italy, Ayed[26] 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[19] in 2000 in Kuwait, Waller[21] in 1994 in England and Gebhard[22] in 1996 in Germany, found 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[18] in 1995 in the USA, it is 7.1 *versus* 8.3 days for pulmonary lobectomy by video-assisted thoracic surgery versus thoracotomy. 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[33] in 1999 who reports an incidence of 5.7% for conventional sternotomy versus 0.9% for the mini-thoracotomy. Regarding the cost of minimally invasive approaches, it remains questionable. Actually, according to Swanson Sj[34] 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[35] 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 at (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[36] 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[37], Turkey[38] and Brazil[39], 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[38,40]. Thus, the practice of these minimally invasive approaches in our developing countries will require a good strategy for patient selection according to defined prescriptions, the use and modification of chest conventional instruments, the moderate use of consumables[40,41]. 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[39]. In non-Thoracic Cardiac Surgery, the thoracotomy with Muscular Saving[18] could be recommended because it gives encouraging results. Moreover, as argued by **Frank Edwin**[40], 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 will apparently be the essential condition for the development of Cardio-Thoracic Surgery in general, and Minimally invasive Cardio-Thoracic Surgery in particular. According to V Joshi[32] 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 intraoperative bleeding.

Conclusion

To improve hospital-stay length and patient comfort, minimally invasive thoracic surgery may be an alternative to conventional thoracic surgery. However, in our low-income country, this surgical option will require this requires not only a good strategy for patient selection, a use of chest conventional instruments, and a use of little consumables, but also a health insurance.

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