Osteosynthesis in severe chest trauma : rationale and results

Gilbert Massard
Service de Chirurgie Thoracique
Hôpitaux Universitaire de Strasbourg

Treatment options for severe chest wall injury

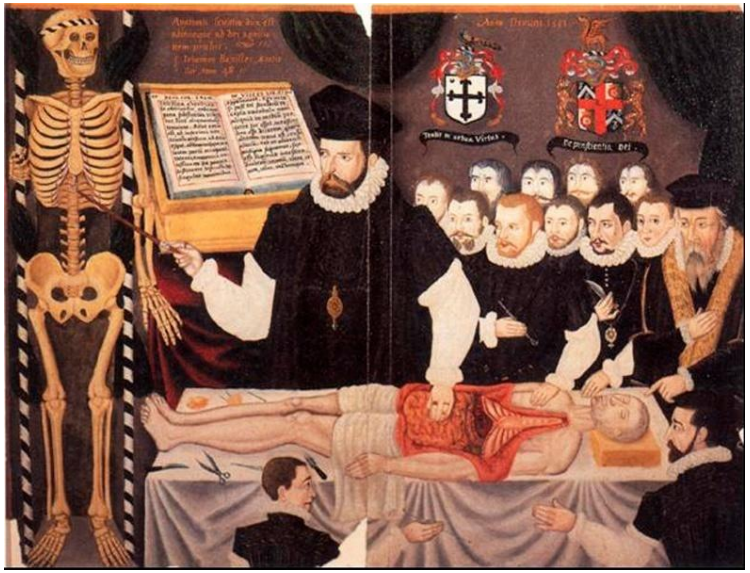
STABILISATION !!!!

- Pneumatic
- External traction
- Osteosynthesis

Epidural analgesia

Why to operate rib fractures : rationale

Evidence based surgery !!



Pierre-Emmanuel Falcoz
Nicola Santelmo & Gilbert Massard

Which is the mortality and morbidity associated with rib fractures ?

Annu Proc Assoc Adv Automot Med. 2008 Oct;52:73-82.

Fatality risk and the presence of rib fractures.

Kent R, Woods W, Bostrom O.

University of Virginia Center for Applied Biomechanics, Dept. of Mechanical and Aerospace Engineering, Charlottesville, VA, USA.

Level 2

Relation AGE – number of rib fractures – MORTALITY

National Trauma Databank USA

Car accident

2 age groups: 18 – 45 vs > 45 years

AIS > 3

181,331 patients

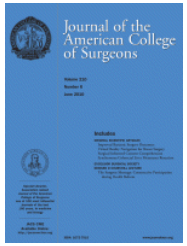
- Death caused by rib fractures:

  O.R. ➔ 1,4 (18-45 years) *vs* 2,5 (>45 years)

- 55% of patients > 60 years dying after chest trauma have no more than rib fractures….

Morbidity from Rib Fractures Increases after Age 45

John B Holcomb, MD, FACS, Neil R McMullin, BS, Rosemary A Kozar, MD, PhD, FACS, Marjorie H Lygas, MS, FNP, Frederick A Moore, MD, FACS



J Am Coll Surg 2003;196:549–555

Relation AGE – number of fractures– MORBI-MORTALITY

Retrospective study– 15 years

171 patients

Level 2

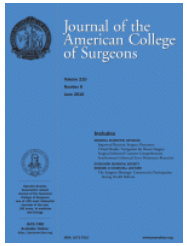
Table 2. Pulmonary Complications and Outcomes

Variables	Group 1 n (%)	Group 2 n (%)	Group 3 n (%)	Group 4 n (%)	p Value
Patients	78 (46)	26 (15)	44 (26)	23 (13)	–
Pulmonary complications					
ARDS	9 (11)	2 (8)	3 (7)	6 (26)	–
Empyema	0	0	2 (4)	0	–
Pneumonia	5 (6)	1 (4)	3 (7)	2 (8)	–
Total	14 (18)	3 (12)	8 (18)	8 (35)	NS
Outcomes					
Ventilator days	2 ± 0.5	1 ± 1	2 ± 1	$6 \pm 2^{*,\dagger,\ddagger}$	$p < 0.05$
ICU days	2 ± 0.5	3 ± 1	2 ± 1	$8 \pm 2^{*,\dagger,\ddagger}$	$p < 0.05$
Hospital days	8 ± 1	8 ± 1	7 ± 1	$14 \pm 2^{*,\dagger,\ddagger}$	$p < 0.05$
Deaths	1 (1)	1 (2)	0	1 (4)	–

There were no differences between groups 1, 2, and 3. Group 4 patients demonstrated prolonged ventilator, ICU, and hospital days.

Morbidity from Rib Fractures Increases after Age 45

John B Holcomb, MD, FACS, Neil R McMullin, BS, Rosemary A Kozar, MD, PhD, FACS, Marjorie H Lygas, MS, FNP, Frederick A Moore, MD, FACS



J Am Coll Surg 2003;196:549–555

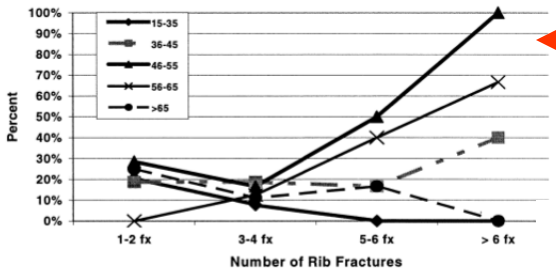


Figure 2. The effect of the number of rib fractures (fx) and age on the number of pulmon complications. Patients are grouped into five age and four rib fracture divisions. Similar d were used for each of the outcomes variables.

Pulmonary complic.

Level 2

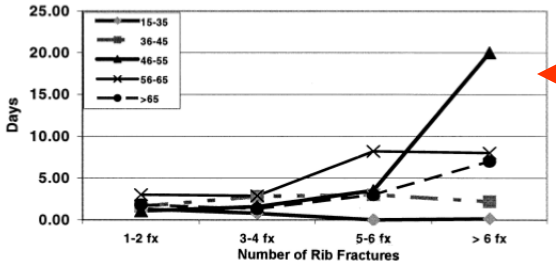


Figure 1. The effect of the number of rib fractures (fx) and age on the number of ventilator days. Patients are grouped into five age and four rib fracture divisions. Similar data were used for each of the outcomes variables.

Duration of intubation

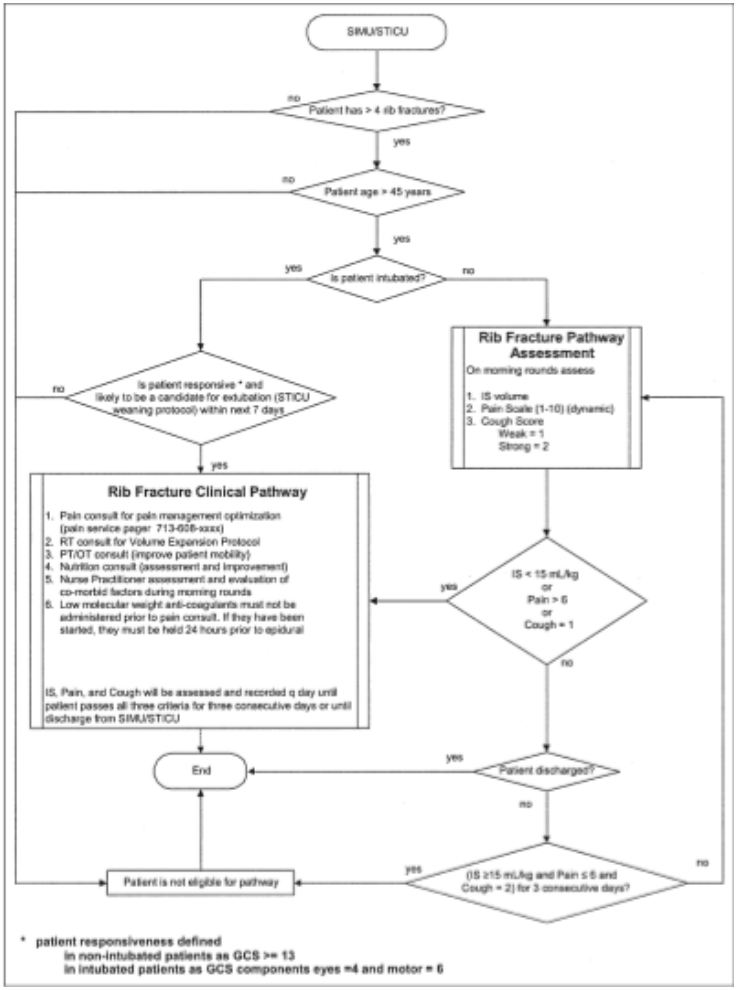
CONCLUSIONS: Patients over the age of 45 with more than four rib fractures are more severely injured and at increased risk of adverse outcomes. Efforts to decrease rib fracture morbidity should focus not only on elderly patients but those as young as 45 years. Based on these data we have initiated a multidisciplinary clinical pathway focusing on patients 45 years and older who have more than four rib fractures. (J Am Coll Surg 2003;196:549–555. © 2003 by the American College of Surgeons)

A multidisciplinary clinical pathway decreases rib fracture–associated infectious morbidity and mortality in high-risk trauma patients

S. Rob Todd, M.D.[a,*], Michael M. McNally, M.D.[b], John B. Holcomb, M.D.[c], Rosemary A. Kozar, M.D., Ph.D.[b], Lillian S. Kao, M.D.[b], Ernest A. Gonzalez, M.D.[b], Christine S. Cocanour, M.D.[f], Gary A. Vercruysse, M.D.[g], Marjorie H. Lygas, M.S.[d], Bobbie K. Brasseaux, R.R.T.[e], Frederick A. Moore, M.D.[a]

The American Journal of Surgery 192 (2006) 806–811

Level 2



Prospective cohort study
Patient > 45 years AND > 4 rib fractures
2 groups of 150 patients
BEFORE and AFTER
Multidisciplinary clinical pathway

Multidisciplinary clinical pathway
Adjustment on age / ISS / Nb of rib fractures :

- ↘ 2,4 days in ICU (p=0.01)
- ↘ 3,7 hospital stay (p=0.02)
- ↘ Nb pneumonias (OR=0.12; p=0.001)
- ↘ Mortality (OR=0.37;p=0.06)

Flail chest : osteosynthesis or pneumatic internal fixation ?

Surgical Stabilization of Internal Pneumatic Stabilization? A Prospective Randomized Study of Management of Severe Flail Chest Patients

Hideharu Tanaka, MD, Tetsuo Yukioka, MD, Yoshihiro Yamaguti, MD, Syoichiro Shimizu, MD, Hideaki Goto, MD, Hiroharu Matsuda, MD, and Syuji Shimazaki, MD

J Trauma. 2002;52:727–732

Flail chest
37 patients on ventilator

Surgical stabilization
N=18

Internal pneumatic stabilisation
N=19

Randomisation at D5

Surgical Stabilization of Internal Pneumatic Stabilization? A Prospective Randomized Study of Management of Severe Flail Chest Patients

Hideharu Tanaka, MD, Tetsuo Yukioka, MD, Yoshihiro Yamaguti, MD, Syoichiro Shimizu, MD, Hideaki Goto, MD, Hiroharu Matsuda, MD, and Syuji Shimazaki, MD

J Trauma. 2002;52:727–732

Table 2 Incidence of Pneumonia on Days 7 and 21, Length of Mechanical Ventilation, Total Length of TICU Stay, and Incidence of Tracheostomy on Days 7 and 21 in Internal Pneumatic Stabilization and Surgical Stabilization Groups

	Postoperative Day	Incidence of Pneumonia		Total Length (Days after Surgery)		Tracheostomy	
		D7 (%)	D21 (%)	Length of Mechanical Ventilation	Length of TICU Stay	D7	D21
Surgical (n = 18)	8.2 ± 4.1	1/18 (5)	4/18 (22)	10.8 ± 3.4 (2.5 ± 3.2)	16.5 ± 7.4 (9.2 ± 5.2)	0/18	3/18
Internal (n = 19)	NA	3/19 (16)	17/19 (90)	18.3 ± 7.4	26.8 ± 13.2	5/19	15/19
p Value		NS	<0.05	<0.05	<0.05	NS	<0.05

D7, 7 days after injury; D21, 21 days after injury; NA, not available; NS, not significant.
Mean ± SD.

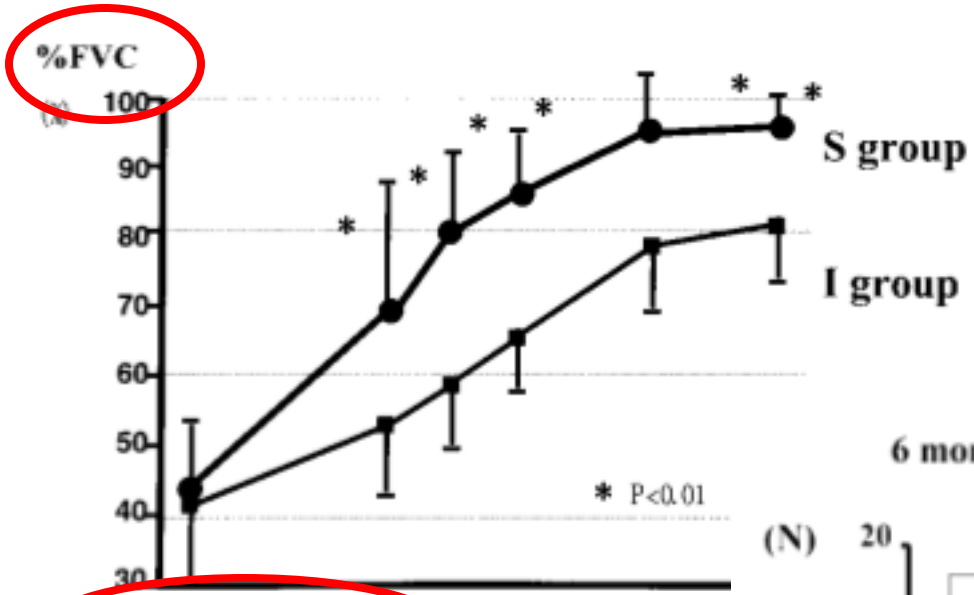
Level 1

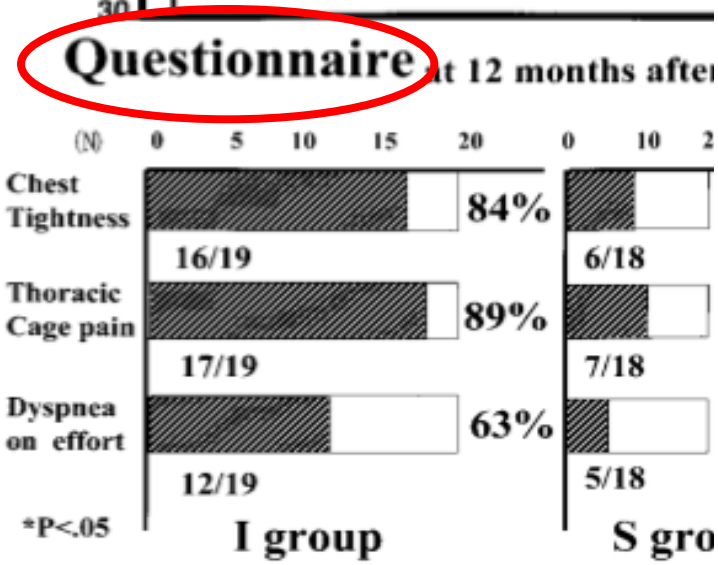
Surgical Stabilization of Internal Pneumatic Stabilization? A Prospective Randomized Study of Management of Severe Flail Chest Patients

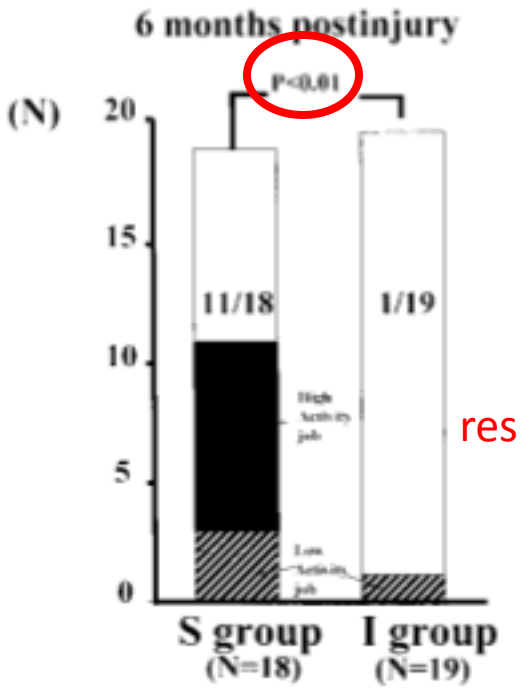
Hideharu Tanaka, MD, Tetsuo Yukioka, MD, Yoshihiro Yamaguti, MD, Syoichiro Shimizu, MD, Hideaki Goto, MD, Hiroharu Matsuda, MD, and Syuji Shimazaki, MD

J Trauma. 2002;52:727–732

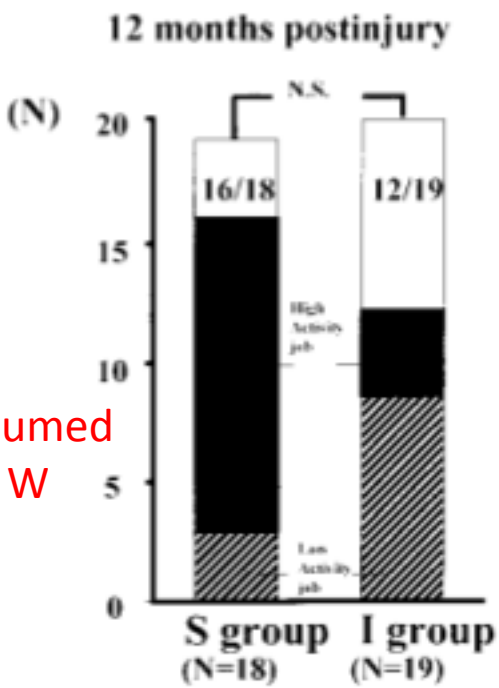
Level 1







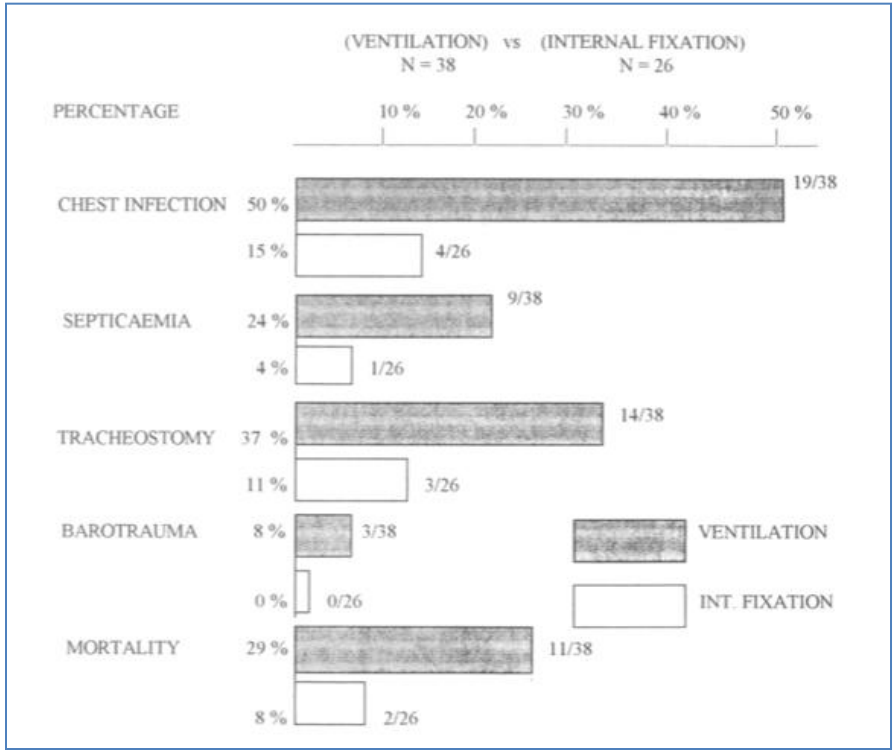
resumed
W



MANAGEMENT OF FLAIL CHEST INJURY: INTERNAL FIXATION VERSUS ENDOTRACHEAL INTUBATION AND VENTILATION

Zahoor Ahmed, and Zahoor Mohyuddin,
Abu Dhabi, United Arab Emirates

J THORAC CARDIOVASC SURG1995;110:1676-80



Prospective study– 10 years
427 chest trauma
64 flail chests
26 surgical stabilisations
38 pneumatic stabilizations

Level 2

Summary of EBM statements

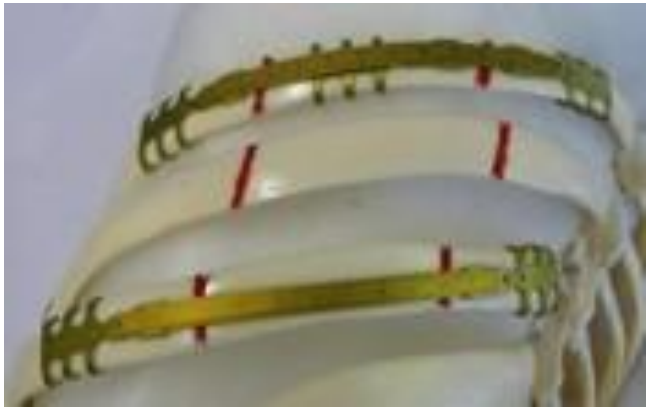
- Mortality and morbidity associated with rib fractures increase with age (> 45 years) and number (> 4 fractures) (level 2)

- Multidisciplinary management of chest trauma may decrease mortality and morbidity (level 2)

- Surgical stabilisation of flail chest decreases mortality and morbidity, decreases duration of mechanical ventilation, ICU and hospital stay, improves functional and cosmetic outcome, and is cost efficient (level 1)

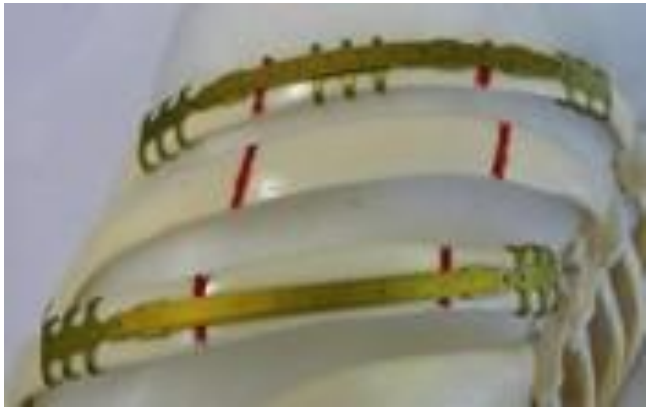
Immediate advantages of surgical stabilisation

- Exploration of the chest
  - adequate drainage of hemothorax
  - identification of associated injuries
- Restoration of chest wall rigidity
  - relieve of pain
  - chest wall motion
  - effective cough
- Immediate mobilization of the patient
  - No prolonged intubation
  - No prolonged bed rest & consequences



Long term advantages of surgical stabilisation

- Decrease of long term complications
  - Chest wall deformity & fibrothorax
  - Pseudarthrosis
  - Chronic pain
  - Restrictive respiratory failure
- Social consequences
  - Decreased ICU & Hospital stay
  - Earlier autonomy & return to work



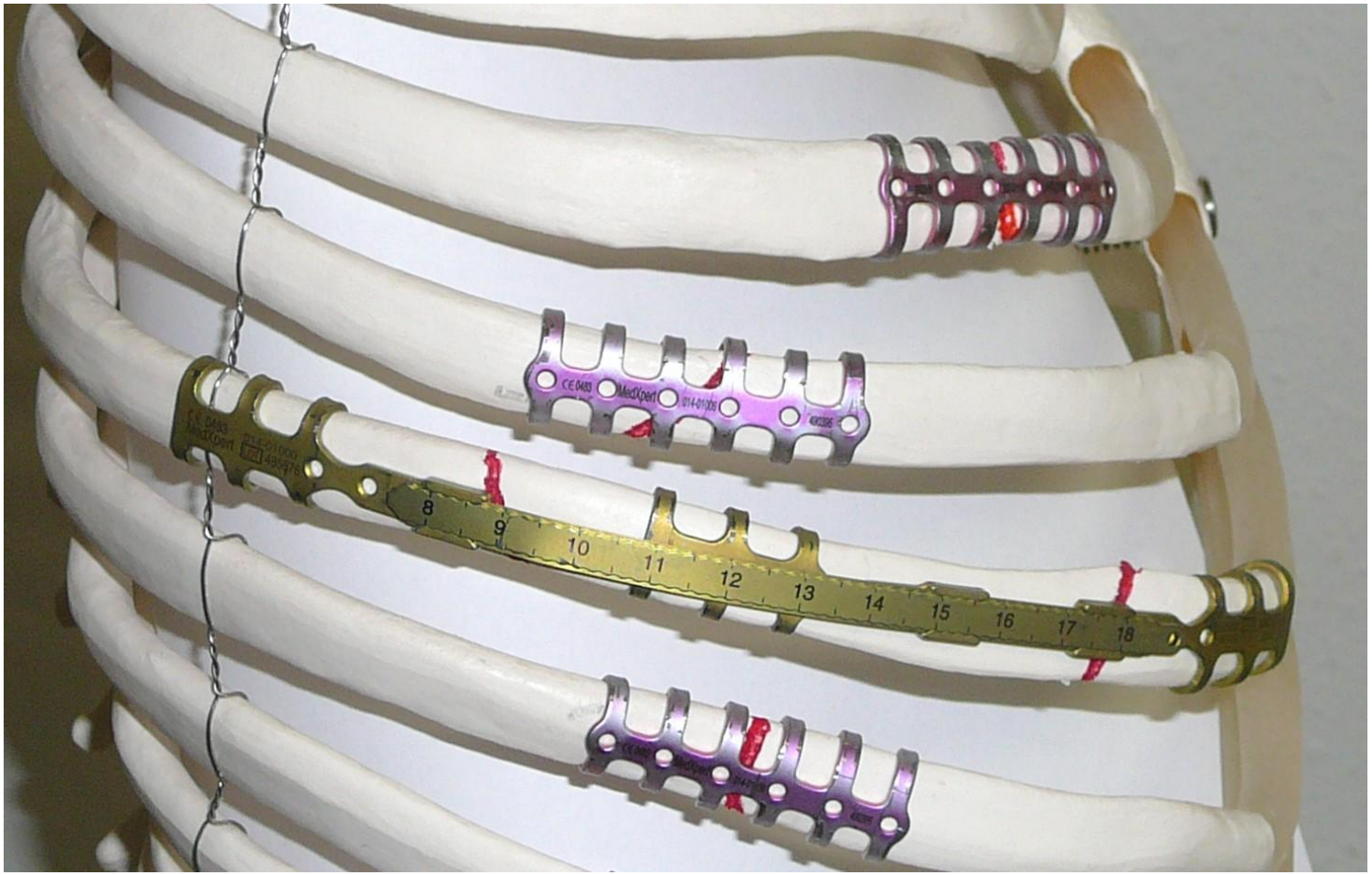
Targets for rib osteosynthesis

- Severe trauma
  - Stabilisation of the chest wall („flail chest“)
  - Repair of chest wall impactation
  - Osteosynthesis of staged rib fractures
- Benign trauma : Osteosynthesis of single rib fractures
  - COPD
  - Poor pain control

When to operate ?

- Routine emergency repair
- Elective repair
  - poor pain control
  - risk for respiratory failure
  - major deformity
- While closing thoracotomy

STRATOS-STRACOS meets all needs in trauma surgery !



- STRACOS -3D clips : **pink** simple fractures
- STRATOS clips with connecting bar : **gold** 3rd fragment / loss of bone

Less satisfactory alternatives

- Simple sutures and wires
  - no garantee for stability !
- Intracostal pins and struts
  - technically difficult
  - risk of migration of material
- Plates & screws (Synthes)
  - very expensive
  - lengthy operation
  - problems with osteoporosis, comminutive fractures

Experience in Strasbourg

- Multidisciplinary consultation since July 2010

Results

July 2010 – August 2011

Patient characteristics	Number (range)
Patients	34
Male	23
Female	11
Median age (years)	65 (18-84)
Comorbidities (patients)	21
- Cardiovascular	18
- COPD	9
- Metabolic disease	13
Flail chest (patients)	11
Bilateral rib fractures (patients)	23
Average number of rib fractures	10.4 (3-29)
Associated lesions (patients)	20

Results

July 2010 – August 2011

Mortality	0	0
morbidity	8	23 %
Mechanical ventilation	2.5 days (0-26)	Med. 0
ICU stay	5 days (0-35)	Med. 0
Hospital stay	15.2 days (3-48)	Med. 12

Risk factor analysis

	ventilation	ICU	Hosp stay	N patients
Comorbidity >1	5.3 d	8.8 d	20 d	13
Comorbidity 1	0.5 d	2.6 d	11.8	21
p	0.02	0.03	0.045	

	Ventilation	ICU	Hosp stay	N patients
COPD	7.25 d	11.1 d	24 d	9
No COPD	0.6 d	2.7 d	11.6 d	25
	0.02	0.007	0.005	

Risk factor analysis

Combined trauma	N patients	Ventilation	ICU	Hosp stay
yes	18	4.3 d	8.8 d	21 d
none	16	0.1 d	0.1 d	7.2 d
p		0.04	0.002	0.01

Metabolic disorders	N patients	Ventilation	ICU	Hosp stay
yes	12	5.2 d	7.8 d	17.4 d
none	22	0.8 d	3.5 d	14 d
p		0.04	NS	NS


149а
АСНЫЙ ПУТЬ
УЛИЦА
А

Conclusions

- Acceptable mortality & morbidity
- Acceptable hospital stay
- Risk factors :
  - Comorbidities
  - COPD
  - Combined injuries
- Social benefit to be evaluated

Merci