

FOUR BONE FUSION:  
CONTROVERSIAL TOPICS  
SURGICAL DEMANDING  
OPERATION

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26° Congresso Brasileiro

De Cirurgia da Mão

FOUR BONE FUSION:

also known as

*mediocarpal fusion (germany)*

*or*

*four corner fusion*

# FOUR BONE FUSION

- The literature
- The goals
- The indications
- The alternatives
- The dilemma
- The techniques

# FOUR BONE FUSION

- The literature: what is realized?
- The goals
- The indications
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- The techniques



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- The alternatives: PRC, total fusion, other?
- The dilemma: how many operations?
- The techniques

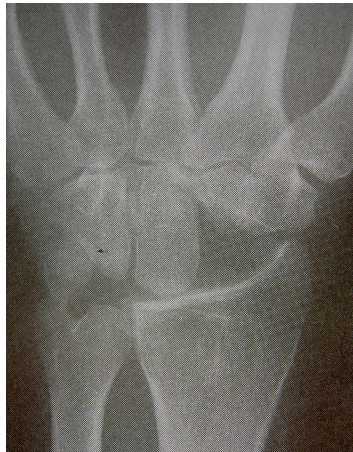
# FOUR BONE FUSION

- The literature: what is realized?
- The goals: why partial fusion?
- The indications: when to do it?
- The alternatives: PRC or total fusion?
- The dilemma: how many operations?
- The techniques: the key point.

# FOUR BONE FUSION

Uncertainty is defined by some papers  
comparing proximal row carpectomy versus  
four-corner arthrodesis:

Wyrick JD: JHS 20A:965-970, 1995



## Motion-preserving Procedures in the Treatment of Scapholunate Advanced Collapse Wrist: Proximal Row Carpectomy versus Four-corner Arthrodesis

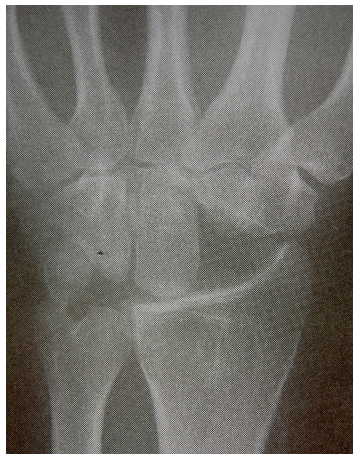
John D. Wyrick, MD, Peter J. Stern, MD, Thomas R. Kiefhaber, MD,  
Cincinnati, OH

Seventeen patients were treated with scaphoid excision and four-corner arthrodesis (lunate, capitate, hamate, triquetrum) for scapholunate advanced collapse wrist and followed for a mean of 27 months. Eleven wrists in 10 patients had a proximal row carpectomy for scapholunate advanced collapse wrist and were followed for a mean of 37 months. The total arc of motion averaged 95° in the four-corner arthrodesis group and 105° in the proximal row carpectomy group.

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four-corner arthrodesis:

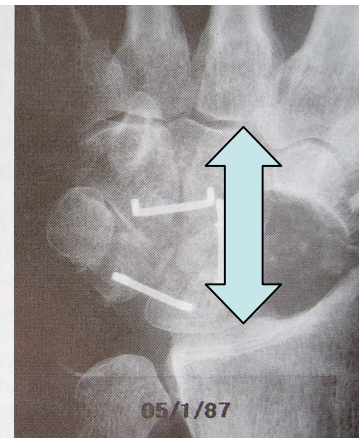
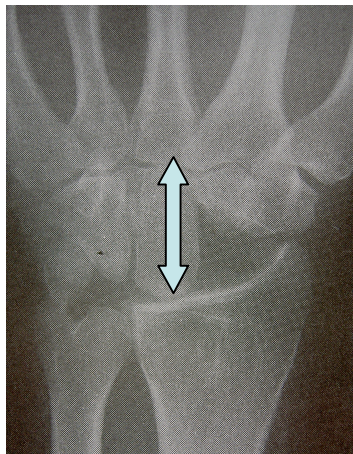
Wyrick JD: JHS 20A:965-970, 1995



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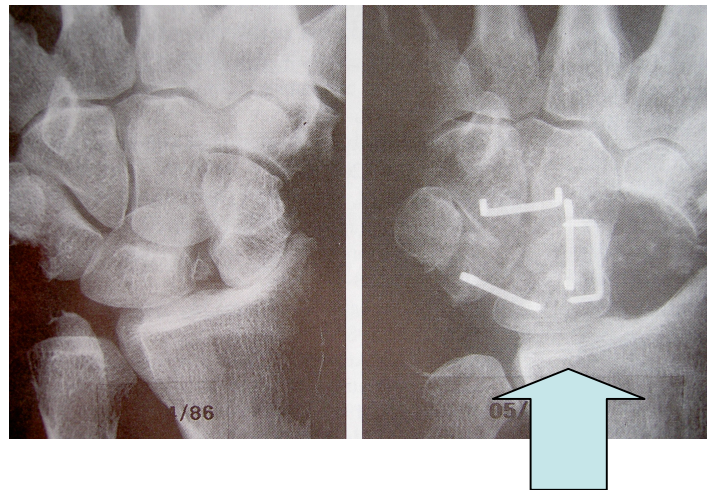
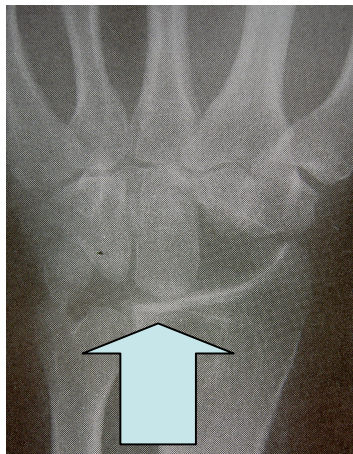




# FOUR BONE FUSION

Uncertainty is defined by some papers  
comparing proximal row carpectomy versus  
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# FOUR BONE FUSION

- Wyrick JD: JHS 20A:965-970, 1995

17 four corner (age 46)

FE: 95° (47%)

11 proximal row carpectomy (age 46)

FE:115° (64%)

# FOUR BONE FUSION

- Wyrick JD: JHS 20A:965-970, 1995

17 four corner.

FE: 95° (47%), Grip: 74%

11 proximal row carpectomy.

FE:115° (64%), Grip: 94%

# FOUR BONE FUSION

- Wyrick JD: JHS 20A:965-970, 1995

17 four corner.

FE: 95° (47%), Grip: 74%, 3 failures

11 proximal row carpectomy.

FE:115° (64%), Grip: 94%, no failures

# FOUR BONE FUSION

- Wyrick JD: JHS 20A:965-970, 1995

Which conclusions?

PRC looks better.

Four bone looks difficult: 12 success out of 17 patients, 30% failure rate!

# FOUR BONE FUSION

- Wyrick JD: JHS 20A:965-970, 1995

Maintenance of carpal height

Does it make sense....

# FOUR BONE FUSION

- Wyrick JD: JHS 20A:965-970, 1995

Does such a comparison make sense at all

# FOUR BONE FUSION

- Viegas SF. Limited arthrodesis for scaphoid non union. JHS 19a:127-33, 1994.

## Limited Arthrodesis for Scaphoid Nonunion

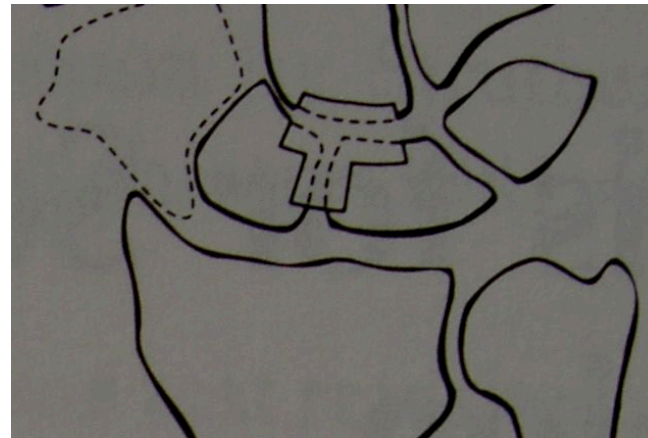
Steven F. Viegas, MD, Galveston, TX



# FOUR BONE FUSION

- Viegas SF. Limited arthrodesis for scaphoid non union. JHS 19a:127-33, 1994.

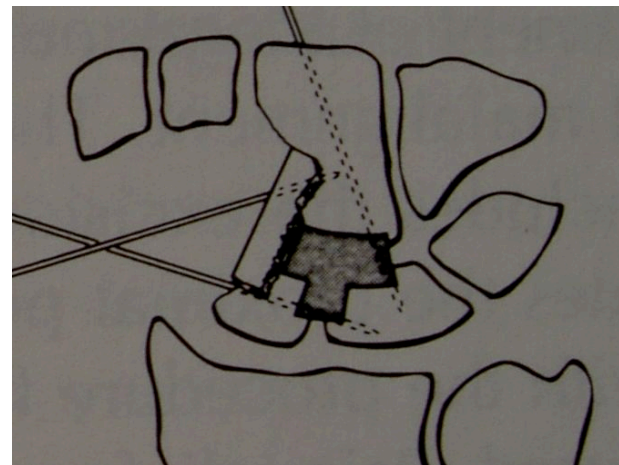
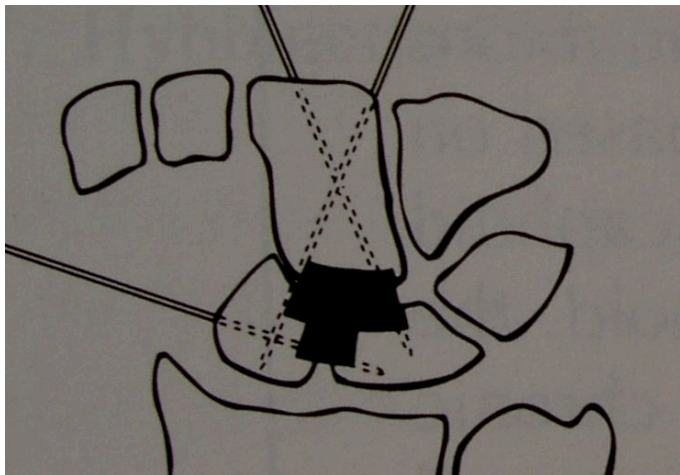
Technique proposed



# FOUR BONE FUSION

- Viegas SF. Limited arthrodesis for scaphoid non union. JHS 19a:127-33, 1994.

Technique proposed



# FOUR BONE FUSION

- Viegas SF. Limited arthrodesis for scaphoid non union. JHS 19a:127-33, 1994.

The presented technique is complex, subtle and maintenance of the carpal height seems required

# FOUR BONE FUSION

- Viegas SF.

## Conclusions

- It allows correction of DISI



prevent late carpal  
collapse (?)

# FOUR BONE FUSION

- Viegas SF.

## Conclusions

- It allows correction of DISI
- prevent late carpal collapse

***But the author does not recommend the procedure for scaphoid non union with good scaphoid bone quality...***

# FOUR BONE FUSION

Tomaino et al. Scapholunate advanced collapse wrist: proximal row carpectomy or limited wrist arthrodesis with scaphoid excision? JHS 19A:134-142, 1994

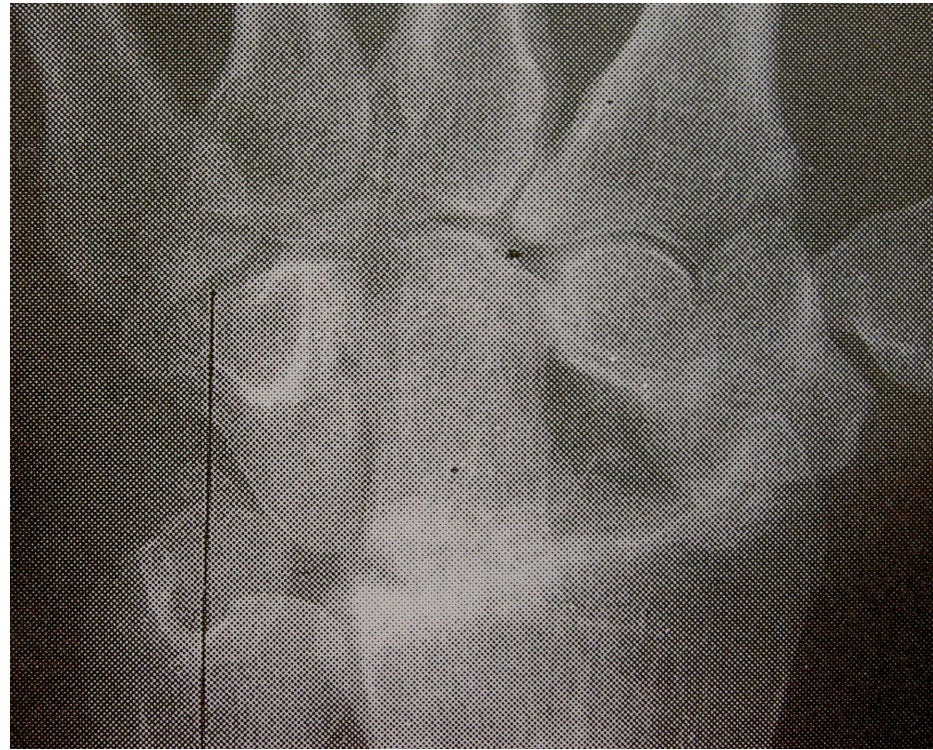
**Scapholunate Advanced Collapse  
Wrist: Proximal Row Carpectomy or  
Limited Wrist Arthrodesis With  
Scaphoid Excision?**

Matthew M. Tomaino, MD, Pittsburgh, PA, Richard J. Miller, MD,  
Ida Cole, MS, Richard I. Burton, MD, Rochester, NY



# FOUR BONE FUSION

Tomaino et al. JHS 19A:134-142, 1994





# FOUR BONE FUSION

Tomaino et al. JHS 19A:134-142, 1994



technique shown

it looks like the

technique of Watson



# FOUR BONE FUSION

Tomaino et al.

	PRC n=15	4_bone n=09
Grip	77% (85-115)	76% (65-103)
FE	77° (50-125)	52° (30-75)
Radial dev.	7° (0-15)	9° (0-20)
Uln dev.	19° (15-30)	13° (0-25)

# FOUR BONE FUSION

Tomaino et al.

In all cases of four bone fusion, maintenance of carpal height.

Again, comparison unsatisfactory for the reader, how long the follow-up!?

# FOUR BONE FUSION

Tomaino et al.

**They concluded:**

**We agree with Watson that four bone fusion is the motion-preserving treatment of choice for the stage III SLAC wrist.**

# FOUR BONE FUSION

Tomaino et al.

**They concluded:**

**When degenerative change is limited to stage I and II, we think PRC is a more appealing option.**

**Less demanding**

**No nonunion**

# FOUR BONE FUSION

Tomaino et al.

**They concluded:**

**When degenerative change is limited to stage I and II, we think PRC is a more appealing option.**

**Less demanding (the reason?)**

**No nonunion**

# FOUR BONE FUSION

Tomaino et al.

**However they report degenerative changes 6 years after proximal row carpectomy.**

*Is logical thinking respected?*

*How long will the radius resist to the head of the capitate?*

# FOUR BONE FUSION

Kitzinger HB et al. Der posttraumatische karpale Kollaps – Längerfristiger Verlauf nach mediokarpaler Teilarthrodese.

Handchir Mikrochir Plast Chir 35:282-287, 2003

**Der posttraumatische karpale Kollaps –  
Längerfristiger Verlauf nach  
mediokarpaler Teilarthrodese**

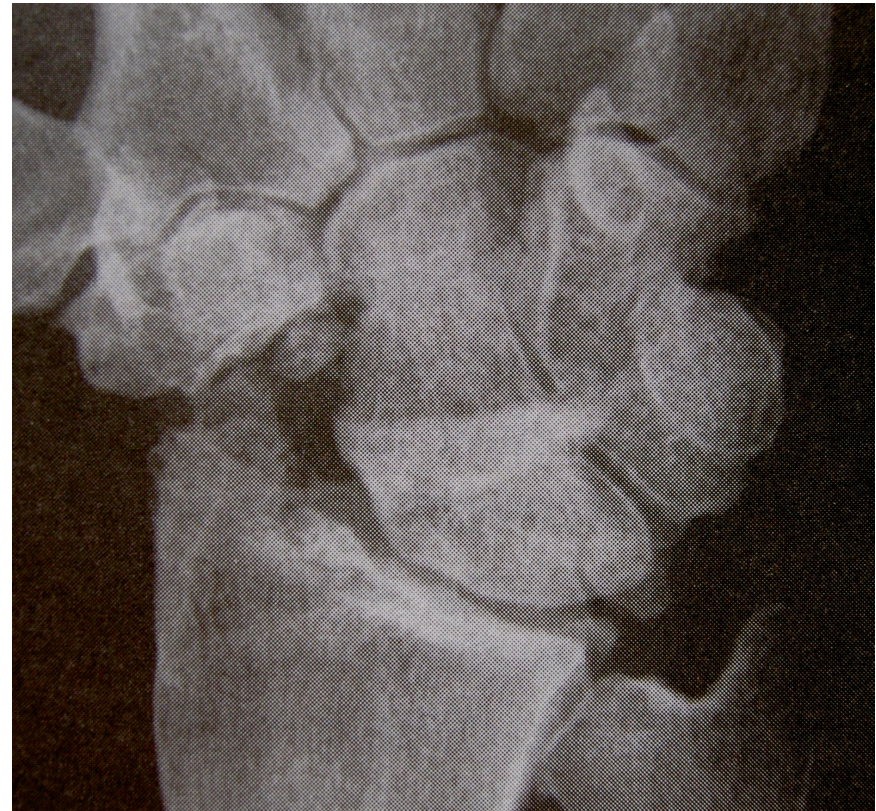
H. B. Kitzinger  
S. Löw  
B. Karle  
U. Lanz  
H. Krimmer

*The Posttraumatic Carpal Collapse –  
Long-Term Results After Midcarpal Fusion*

# FOUR BONE FUSION

Kitzinger HB et al. Handchir Mikrochir Plast Chir  
35:282-287, 2003

The technique:  
Maintenance of  
carpal height.





# FOUR BONE FUSION

Kitzinger HB et al.

Between 1991 und 1995 operated on

**107 patients.**

Were able to review **37** of them.

# FOUR BONE FUSION

Kitzinger HB et al.

Between 1991 und 1995 operated on

**107 patients.**

Were able to review **37** of them.

Quite a problem!

# FOUR BONE FUSION

Kitzinger HB et al.

	Post-op	Pre-op
FE	62°	68
Strength	80%	69%
Pain	1.5	1.7

# FOUR BONE FUSION

Kitzinger HB et al. (but 70 patients missing)

excellent	16	43%
good	12	32%
satisfactory	5	14%
mishap	4	11%

# FOUR BONE FUSION

Kitzinger HB et al. (but 70 patients missing)

In 1/3 of the cases an arthritis between lunate and radius occurred in the presented cases.

# FOUR BONE FUSION

Kitzinger HB et al. (but 70 patients missing)

This might reflect:

An insufficient correction of the lunate,

A secondary gliding of the lunate,

An overcorrection of the carpal height.

# FOUR BONE FUSION

Tünnerhoff H.-G, Haußmann P. Komplikationen nach mediokarpaler Teilarthrodese – Versuch einer Fehleranalyse. Handchir Mikrochir Plast Chir 35:288-298, 2003

**Komplikationen nach mediokarpaler Teilarthrodese –  
Versuch einer Fehleranalyse**

H.-G. Tünnerhoff  
P. Haußmann

*Complications after Midcarpal Arthrodesis –  
Attempt to Analyse the Pitfalls*

# FOUR BONE FUSION

Tünnerhoff H.-G, Haußmann P.

62 Patients

Technique: according to Watson

maintenance of carpal height

Example showing  
the loss of correction





# FOUR BONE FUSION

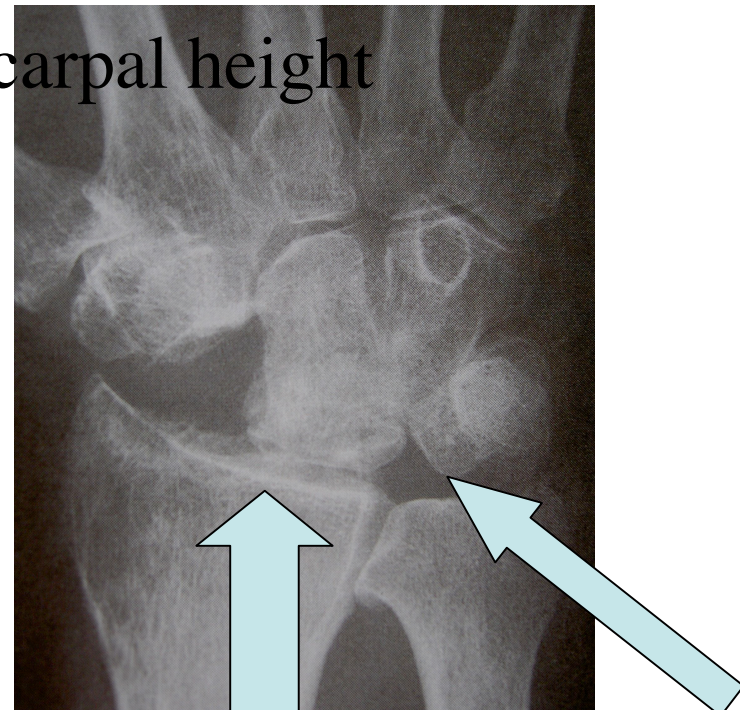
Tünnerhoff H.-G, Haußmann P.

62 Patients

Technique: according to Watson

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Example showing  
the loss of correction



# FOUR BONE FUSION

Tünnerhoff H.-G, Haußmann P.

	N	Bad results
SNAC	27	10
SLAC	34	6
Other	3	0
Total	64	23 (36%)

# FOUR BONE FUSION

Tünnerhoff H.-G, Haußmann P.

They noticed, that reduction of the lunate is the key of success.

But that lunate was difficult to maintain in the corrected position.

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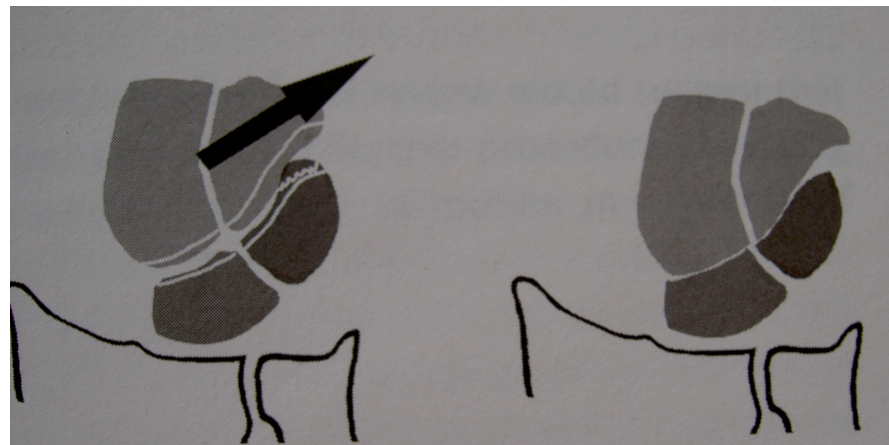
But that lunate was difficult to maintain in the corrected position.

They pointed the problem of chondrocalcinosis.

# FOUR BONE FUSION

Tünnerhoff H.-G, Haußmann P.

They further pointed out the importance to translate the capitate on the lunate.



# FOUR BONE FUSION

Tünnerhoff H.-G, Haußmann P.

But they did not suggest shortening!

# FOUR BONE FUSION

Streich NA, Martini AK, Daecke W. Resektion der proximalen Handwurzelreihe bei Karpal Kollaps. Handchir Mikrochir Plast Chir 35:299, 2003

. Streich  
. Martini  
. Daecke

**Resektion der proximalen Handwurzelreihe  
bei karpalem Kollaps**

*Proximal Row Carpectomy in Carpal Collapse*

# FOUR BONE FUSION

Streich NA, Martini AK, Daecke W.

Mean follow up: 5 years.

However, the title of the paper is wrong.

They reviewed all the carpectomy done... 3 SLAC  
out of 17 patients.

Nevertheless: they are satisfied...



# FOUR BONE FUSION

Streich NA, Martini AK, Daecke W.

A funny kind of paper,

Much confusing

# FOUR BONE FUSION

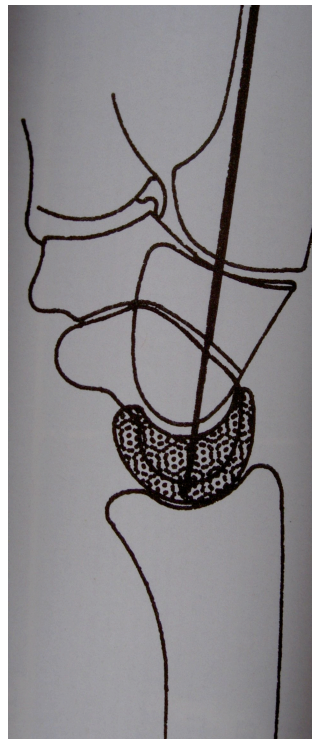
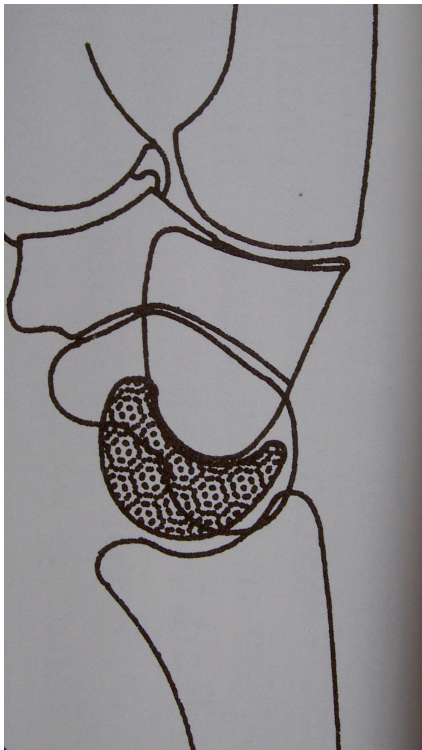
Sennwald G, Segmüller G, Arthrodèse de la colonne centrale du carpe, indications, techniques, résultats. International Orthopaedics (SICOT) 13:147-152, 1989

25 wrists, CL arthrodesis, scaphoid remained in place.

# FOUR BONE FUSION

Sennwald G, Segmüller G

Technique: reduction of the lunate,  
to gain length



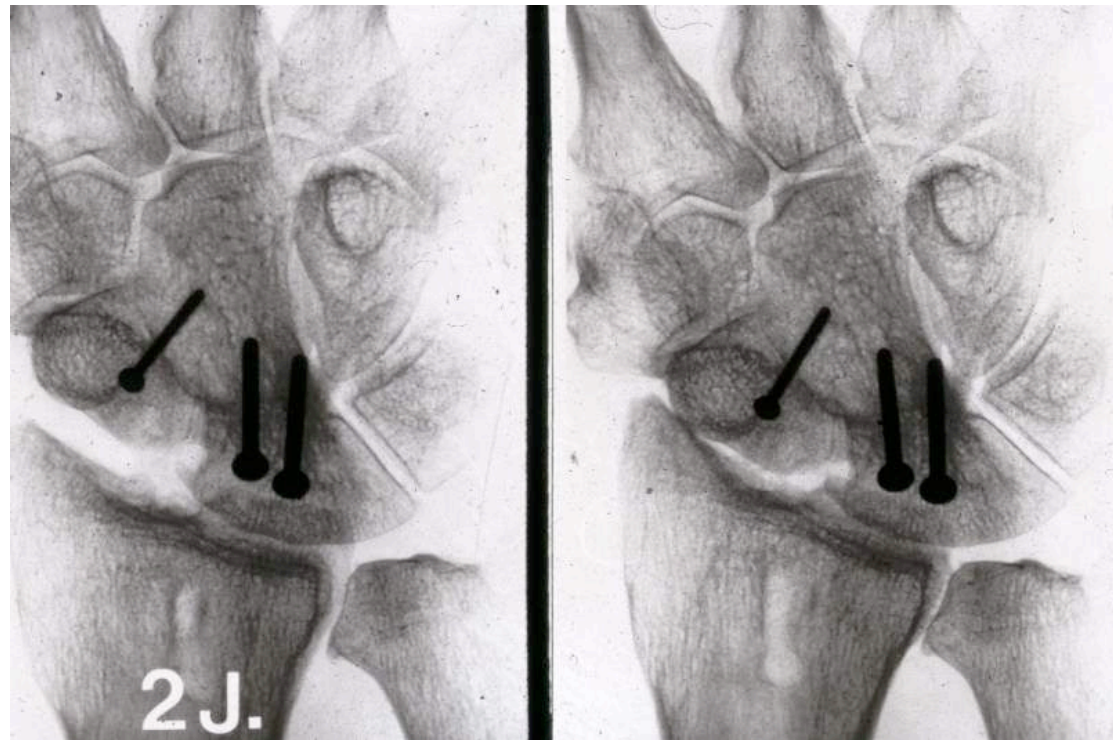
place to the  
scaphoid  
compensate  
loss of height.  
on difficult

# FOUR BONE FUSION

Sennwald G, Segmüller G

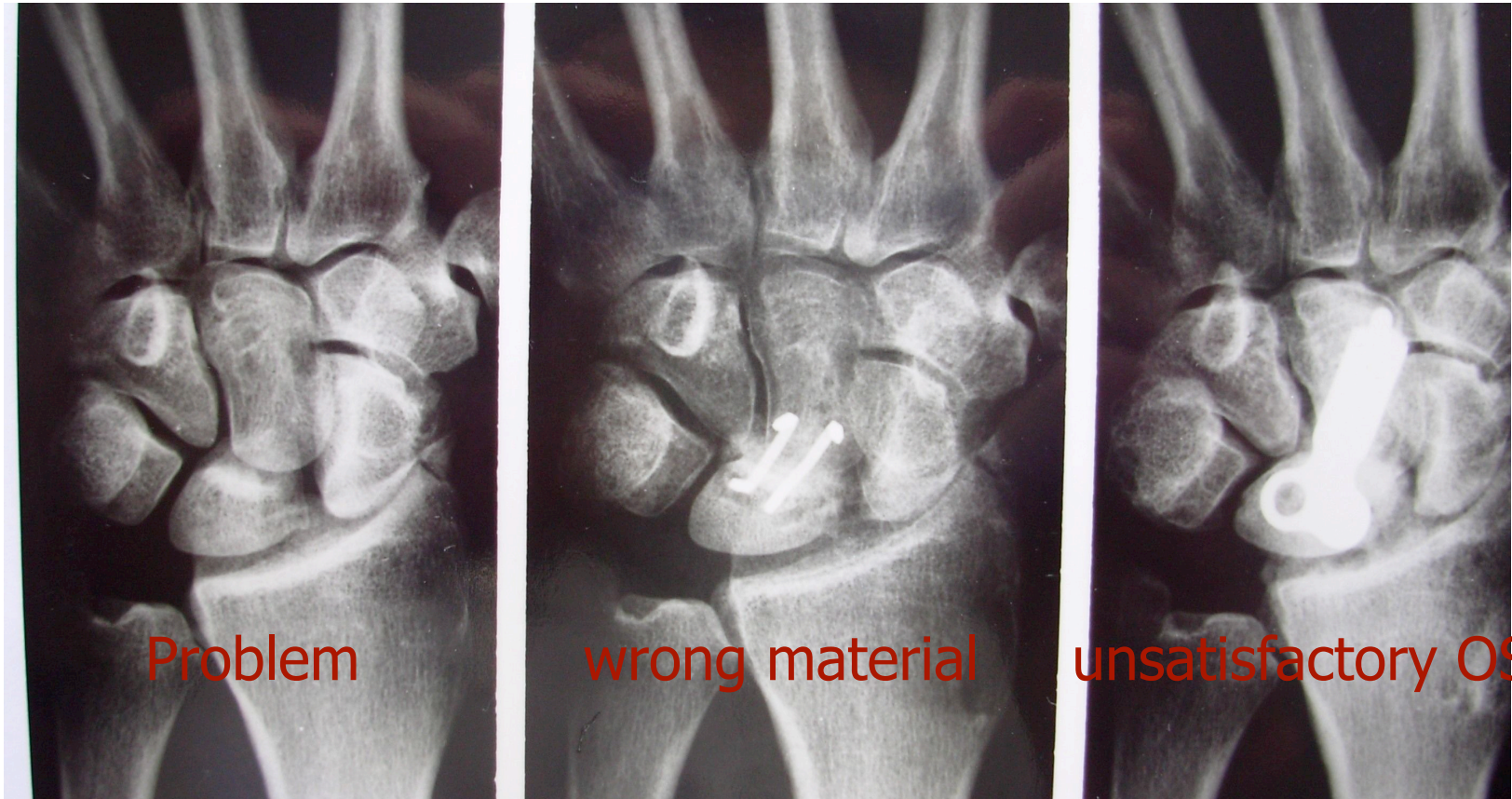
Technique

Scaphoid might  
disturb!



# FOUR BONE FUSION

Sennwald G, Segmüller G





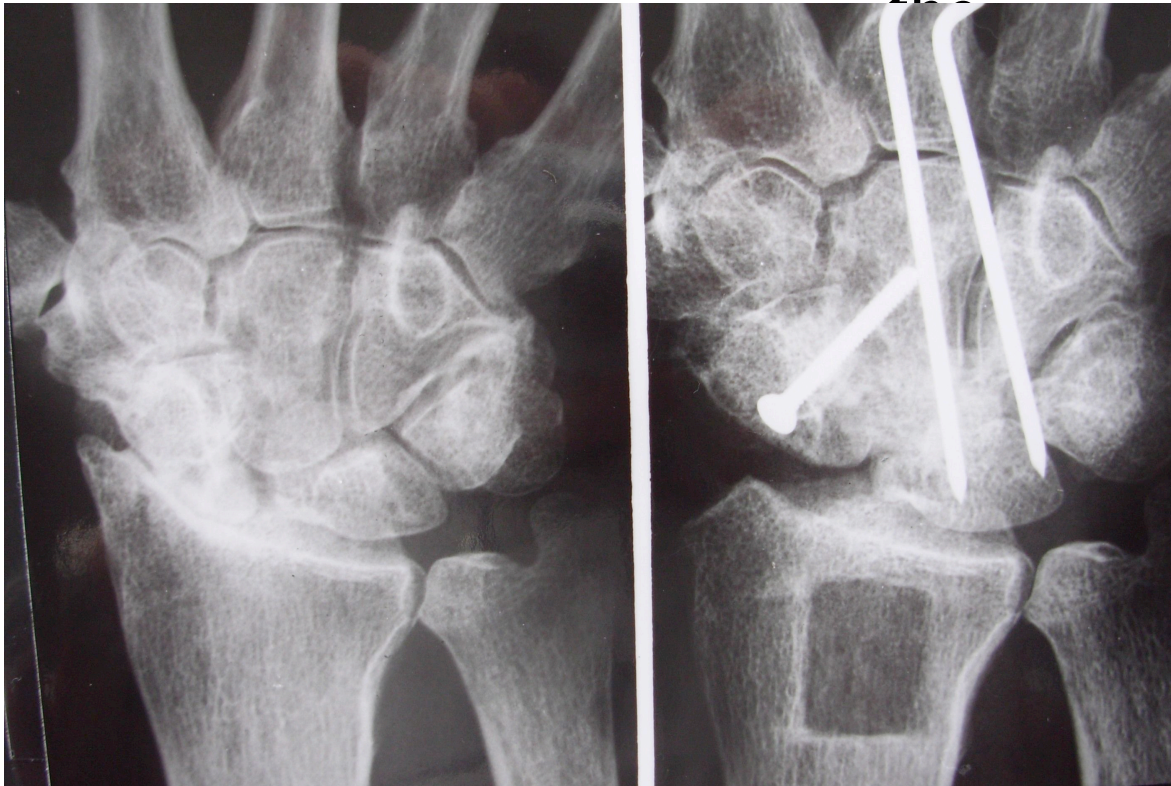
# FOUR BONE FUSION

Sennwald G, Segmüller G



# FOUR BONE FUSION

Sennwald G, Segmüller G



# FOUR BONE FUSION

Sennwald G, Segmüller G

Pan arthrodesis                      3 cases.

New occupation                      6 cases

Return to normal                      13

FE: mean 49.2°

mean follow-up 2 years.



# FOUR BONE FUSION

Sennwald G

I abandoned this technique

Demanding

Scaphoid requires maintenance of carpal height

Anatomy not quite adapted (capitate)

Simplification necessary, especially if PRC is efficient despite shortening.

# FOUR BONE FUSION

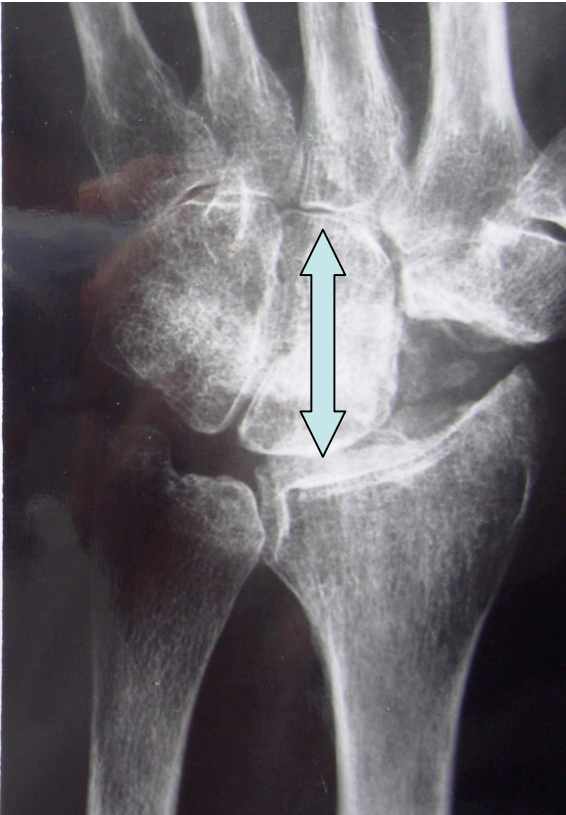
Special problem



problem  
ing to  
lution

# FOUR BONE FUSION

Special problem



problem  
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# FOUR BONE FUSION

Carpal height is not mandatory for function.

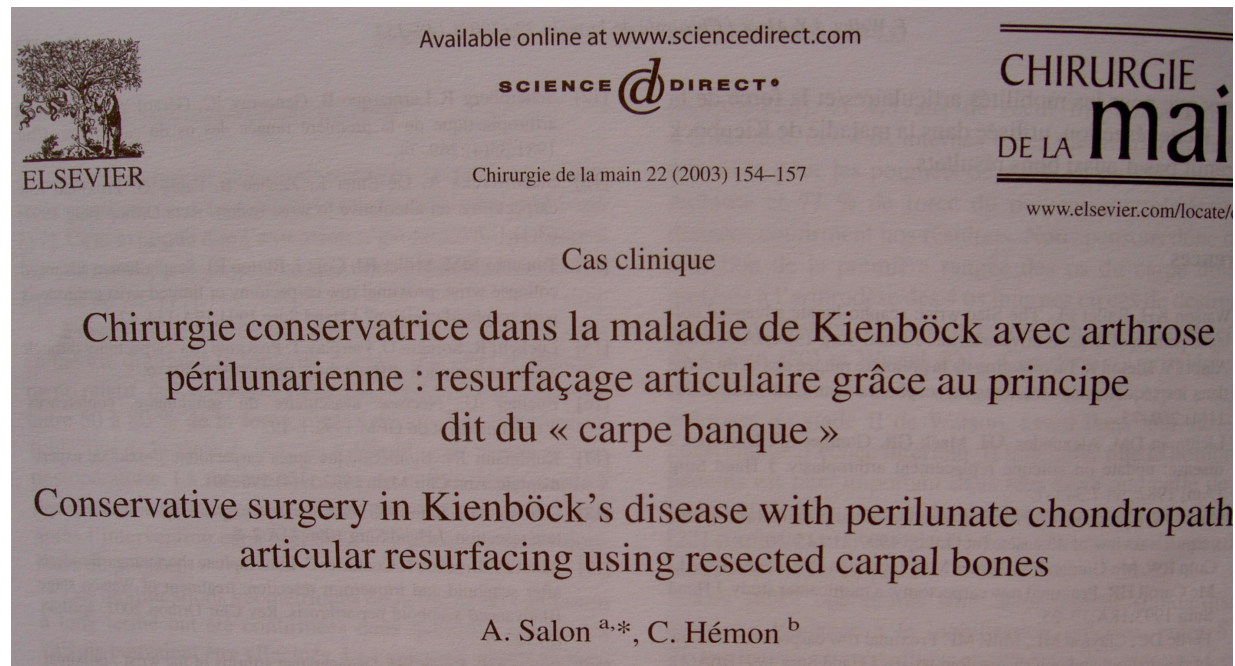
# FOUR BONE FUSION

Alternatives for the capitate head



# FOUR BONE FUSION

A. Salon, C. Hémon. Resurfaçage articulaire grâce au principe du carpe banque.  
Chirurgie de la main 2003, 154

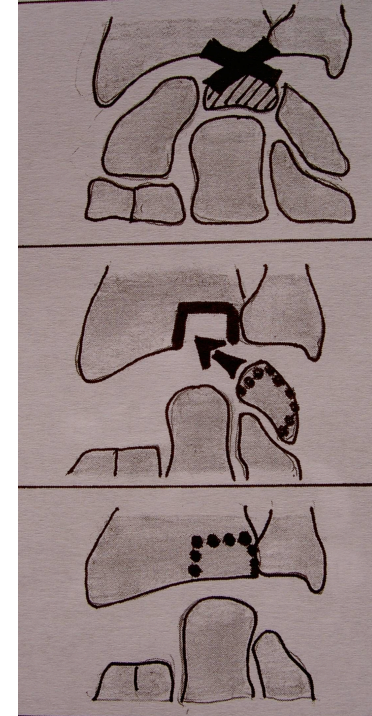


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Salon, C. Hémon. Resurfaçage articulaire  
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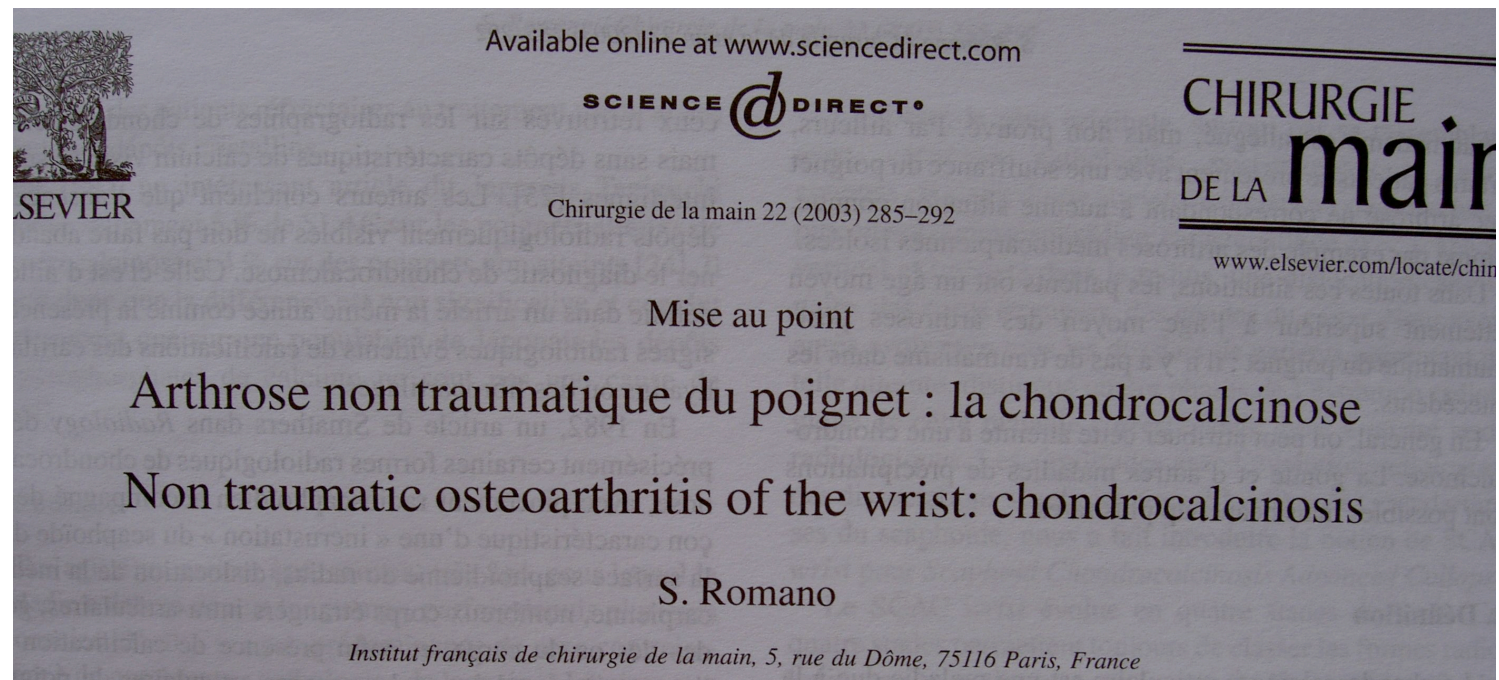
Chirurgie de la main 2003, 154

However, the congruency  
problem is not solved



# FOUR BONE FUSION

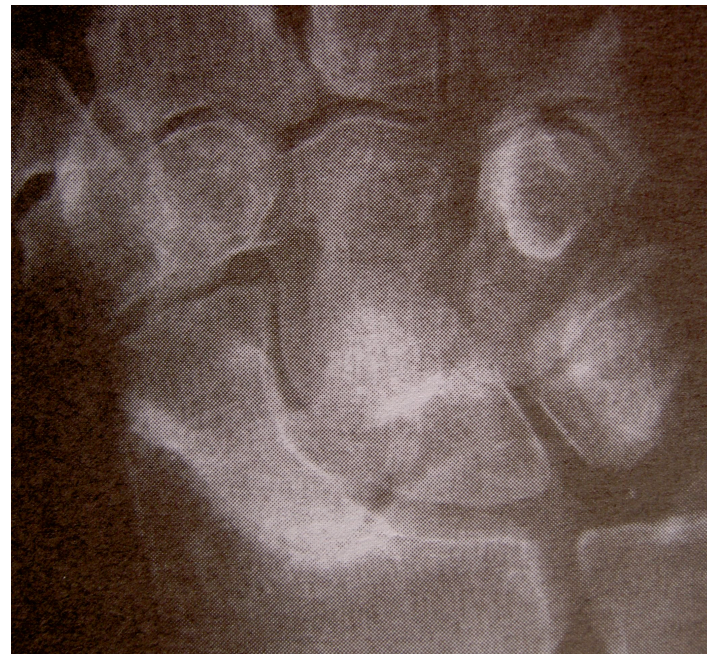
S. Romano, arthrose non traumatique du poignet: la chondrocalcinose. Chirurgie de la main 22: 285, 2003





# FOUR BONE FUSION

S. Romano, Chirurgie de la main 22: 285,  
2003





# FOUR BONE FUSION

S. Romano, Chirurgie de la main 22: 285,  
2003



# FOUR BONE FUSION

S. Romano, Chirurgie de la main 22: 285,  
2003



**Lunate used instead of  
Capitate**

**Resection of triquetrum  
and scaphoid**

# FOUR BONE FUSION

- G. Hoël, Résultats à long terme de la  
“pseudoresection de première rangée des os  
du carpe”

GEM, Paris, 15-18 décembre 2005.

Exactly the technique shown by

Romano

# FOUR BONE FUSION

- G. Hoël

36 wrists, from 1988 – 1998.

8 PRC

8 Watson

20 specific operations

# FOUR BONE FUSION

- G. Hoël: no arthritis on time

	PRC (8)	Watson (8)	Lunate (20)
Total fusion	3 (37.5%)	1	1
Strength		66%	92.5%
FE		58°	70°
Painless	25%	33%	95%
Follow up	arthritis		10 years

## FOUR BONE FUSION

- G. Hoël:
- **NO ARTHRITIS, more than 10 years follow-up**

# FOUR BONE FUSION

- Delattre O, Cousin A, Serra C. GEM 2005

n=25	none	On forced motion	permanent
pain	10	12	3
Total fusion			1
FE	68°	NB: shortening no arthritis on time	
Grip	73%		



- # FOUR BONE FUSION
- More than 10 years



- Everyone wanted to make a total fusion!
- Question: for what the triquetrum?

- # FOUR BONE FUSION
- More than 10 years

This clearly shows  
that

- We don't need the carpal height,
- We don't need the triquetrum,
- We just need a good joint....

So I am not alone.... thank some original French  
authors

# FOUR BONE FUSION

- The goal of partial fusion (watson)
  - Preserve (functional) motion
  - Eliminate pain
  - Eliminate instability
  - Eliminate arthrosis
  - Insure permanent results
  - Enable return to work (daily living)

# FOUR BONE FUSION

- Principles of partial fusion according to Watson, in The Wrist)
  - Unaffected joint must be left unfused
  - The normal external dimensions of the carpal bones must be preserved.
  - Bony fixation should include only those bones involved in the arthrodesis.

# FOUR BONE FUSION

- Principles of partial fusion (Watson, The Wrist)
  - ~~– Unaffected joint must be left unfused~~
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# FOUR BONE FUSION

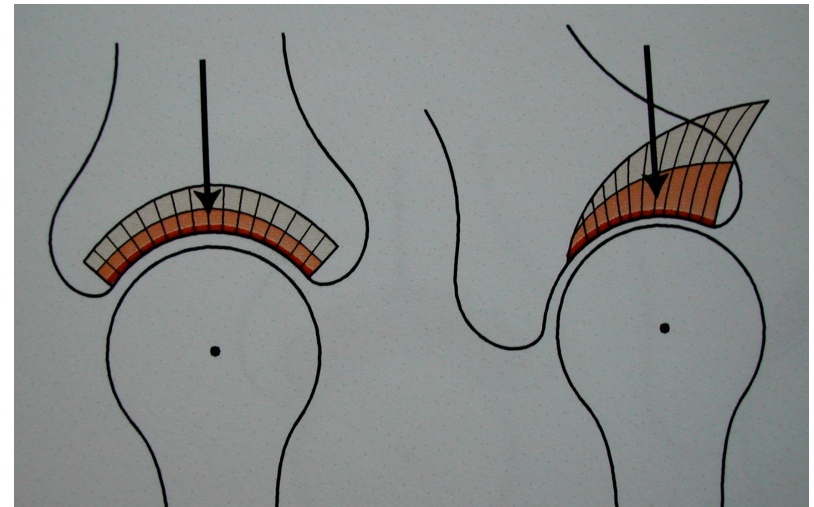
- Principles of partial fusion (Watson, The Wrist)
  - ~~Unaffected joint must be left unfused~~
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# FOUR BONE FUSION

- Principles of partial fusion (Watson, The Wrist)
  - ~~Unaffected joint must be left unfused~~
  - ~~The normal external dimensions of the carpal bones must be preserved.~~
  - ~~Bony fixation should include only those bones involved in the arthrodesis.~~

# FOUR BONE FUSION

- Problems bound to partial fusion:
  - A. Joint congruency
  - B. Joint motion
  - C. Load transfer
  - D. Joint surface





# FOUR BONE FUSION

- Problems bound to partial fusion:
- Pathology:
  1. Idiopathic
  2. Traumatic
  3. Rheumatic

# FOUR BONE FUSION

- Problems bound to partial fusion:
- Pathology:
  1. Idiopathic: SL dissociation
  2. Traumatic: SNAC - SLAC
  3. Rheumatic: never 4 bone fusion!

# FOUR BONE FUSION

- Problems bound to partial fusion:

Arthritis: i.e.

Inflammation

Contracture

shortening of ligaments

# FOUR BONE FUSION

- Problems bound to partial fusion:  
evidence
  - a. shortening of the wrist induces no problem (see proximal row carpectomy),  
accordingly,
  - b. there is no need to maintain the carpal height, this is a myth.

# FOUR BONE FUSION

- Problems bound to partial fusion:

evidence

- c. There is no need to preserve some joints, danger of overload, i.e. secondary arthritis
- d. There is no need to use the capitate head.

# FOUR BONE FUSION

- Problems bound to partial fusion:

evidence

e. There is no mechanical need to maintain the triquetrum.



# FOUR BONE FUSION

- Conclusions

Use the lunate instead of capitate head.

i.e. shorten the wrist.

eliminate the triquetrum

advantages: no problem with the

pisotriquetral joint.

Technically easier.



# FOUR BONE FUSION

- Conclusions

Remember:

PCR might not  
be a definitive  
answer, but an  
early illusion



# FOUR BONE FUSION

- Conclusions  
But solution  
exists.

I would however  
suggest to let  
the nature give  
the correct answer  
with the lunate head



# FOUR BONE FUSION

Obrigado