Brace Treatment of Chest Wall Deformity, Scoliosis and Chest Wall Programs

Davi P. Haje, MD, PhD
Moacir Silva Neto, MD
Sydney A. Haje, MD (in memorian)

Centro Clínico ORTHOPECTUS
Hospital de Base do DF – SES – GDF
Brasília, DF, Brazil

Literature about treatment of pectus excavatum and carinatum with braces

• **1977 to 2014:** Haje et al published 24 papers about braces treatment of carinatum and excavatum

  - **1993:** Mielke e Winter (n=1)
  - **1999:** Beirão (n=30)
  - **2000:** Egan e cols (n=5)

• **2006 – 2014:** others 20 papers about braces treatment of pectus carinatum (braces became first treatment option in a lot of centers for carinatum)

• **Only Haje published papers / book chapters about braces treatment of:**
  - Pectus excavatum
  - Superior carinatum or Currarino type

Treated 36 pectus carinatum
<table>
<thead>
<tr>
<th>Year</th>
<th>Age</th>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>9yo</td>
<td>Control group</td>
<td>No growth plate lesion</td>
</tr>
<tr>
<td>2002</td>
<td>17yo</td>
<td>Group with lesion of growth plates</td>
<td>Growth plate lesion</td>
</tr>
</tbody>
</table>

**HAJES PAPERS ABOUT ETIOLOGY OF PECTUS**

1) Describe the presence of growth plates between the sternal segments and costocondral junction.

2) Provoked pectus deformities in animals by the lesion of these growth plates.


Haje: described the possibility of iatrogenic pectus after sternotomy for repair of cardiac problems.

First literature paper about iatrogenic pectus

After Haje’s treatment
Haje: Pectus deformities are caused by growth disturbances of heredity origin

They usually GET WORSE without treatment in the adolescence!

- abnormal respiratory patterns?
  - pectus patients have earlier, severe, and more frequent asthma (Cserháti et al., 1984)
  - Hajes 5791 patients → 15% of asthma = NORMAL POPULATION

- abnormal muscular balance in the trunk?
NON SURGICAL TREATMENT PRINCIPLES

WRONG TREATMENT PRINCIPLES: Never prescribe just gym exercises without braces for CARINATUM patients

Spontaneous breathing

Doing Valsava maneuver
Did only gym exercises. Got muscles but kept the pectus

October 2014
17 years old

Got better after doing exercises using braces

June 2015

8 MONTHS

Never prescribe just gym exercises without braces for pectus

Treatment of Pectus Carinatum and Excavatum by Haje’s Method —

Treatment Principles – based on orthopaedic principles

Nicolas Andry
France, 1741

Bone remodeling
Julius Wolff  Germany, 1892
Before treating pectus with braces and exercises you need to understand that bone can remodel or reoriented.

...and this kind of treatment was used before 1977 in orthopaedic.

In 1979: Haje first description of pectus treatment with braces (RBO, v. 14, p. 167)

1977

DCC I – dynamic chest compressor

1988: began treatment of pectus excavatum with DCC II (JPO, v. 12, p. 795)
Dynamic Remodeling (DR) method: braces + exercises (Haje, SA et al, 2006): CARINATUM

External pressure of Dynamic Chest Compressor (DCC) braces on protruded areas

Exercises that increase the pressure in the protruded areas that have the brace on: carinatum can correct faster


Dynamic Remodeling (DR) method: braces + exercises HOW CAN CORRECT EXCAVATUM?

Exercises that increase the intrathoracic pressure along with the use of DCC pressure on depressed areas

External pressure of DCC braces on protruded areas: flared ribs and sometimes above nipple

Video 1

Video 2
Dynamic Remodeling (DR) method: braces + exercises HOW CAN CORRECT EXCAVATUM?

Correcting the inferior ribs helps to correct the depressed area: ribs excess in corrected position may give more support to the upper chest (?)

Dynamic Remodeling (DR) method: braces + exercises: HOW CAN CORRECT EXCAVATUM?

Correcting the inferior ribs helps to correct the depressed area: may help respiratory muscles to work better (?) and may increase intrathoracic pressure (?)
Treatment of Pectus Carinatum and Excavatum by braces and exercises (HAJE’S METHOD)

- For that we have a PROTOCOL FOR treating each type of pectus and for:
  - Assessing the patient for the first time
  - Making the measures of the brace
  - Adjusting the brace for the first time and in follow-up
  - Exercises protocol
  - Protocol of assessing patient in returning visits and weaning phase

Developed a specific software and forms

Form for first consultation
Forms for braces
Forms for follow-up
Forms for patient
ETC...

HAJE AND HAJE CLASSIFICATION FOR PECTUS

Pectus Carinatum
- Inferior PCI
- Lateral PCL
- Superior PCS

Pectus Excavatum
- Localized PEL
- Wide PEW

Proposing a modification in Hajes classification (2013):

**Pectus Excavatum**

- Localized PEL
- BIG CENTRAL DEPRESSION + LITTLE FLARED RIBS (type 1)
- DEPRESSION + FLARED RIBS OF SAME PROPORTION (type 2)
- LITTLE DEPRESSION + BIG FLARED RIBS (type 3)

Proposing a modification in Hajes classification (2014):

**Pectus Carinatum**

- Superior PCS
- Very high above NIPPLE LINE (CURRARINO TYPE – type 1)
- JUST ABOVE NIPPLE LINE (type 2)
Proposing a modification in Hajes classification (2015):

- Pectus Excavatum
- Wide
- PEW

Wide DEPRESSION (type 1)

Wide DEPRESSION in lower chest (type 2)

Assimetric wide DEPRESSION (type 3)

HAJE: DESCRIBED THAT PECTUS HAS DIFFERENT FLEXIBILITY LEVELS AND THAT CAN IMPACT TREATMENT PROGNOSIS (1992, JPO)

- Rigid (F0)
- Mild flexibility (F1)
- Moderate flexibility (F2)
- Very flexible (F3)
Treatment of Pectus Carinatum and Excavatum by a TREATMENT Method (HAJE’S METHOD)

• YOU NEED A PROTOCOL OR STANDARIZED APPROACH OF:
  • Assessing the patient for the first time
  • When proposing treatment: one of the most important point is the psychological one ➔ easy to treat motivated patients
    • Show photos of other patients treated and simplify treatment
    • Most of adolescents are worried if they have to wear the brace at school – “show that the brace is no big deal and temporary”

Tell the kids that they can adorn the brace

Some patients do not like to tell others why they are using the brace...
The patients may tell others that they are treating their spine....

Better to use over the shirt
Using the brace inside the shirt
MEDICAL PROTOCOL FOR
PECTUS ORTHOTIC
TREATMENT

1. Compliance is essential for a successful treatment

2. Use the DCC(s) 23 hours a day
   If use less than 18-15 hours a day: no or little correction
   If use 12 hours: avoiding getting worse
   Do exercises everyday

3. To avoid recurrence: gradual weaning/release from the braces, in one, two or more years*.

Also explain that:

TO NOT HAVE RECURRENT: AFTER GETTING BETTER NEEDS TO USE THE BRACE FOR SLEEPING AND FOR GYM EXERCISES UNTIL SKELETAL MATURITY
BOYS – 16 – 17 YEARS OLD
GIRLS – 14 - 15 YEARS OLD
GREAT CORRECTION
STOPED TREATMENT AND JUST DID GYM EXERCICES
STARTED TREATMENT AGAIN

EXAMPLE OF RECURRENCE
OVERCORRECTION
GREAT CORRECTION

STOPED TREATMENT AND JUST DID GYM EXERCICES
STARTED TREATMENT AGAIN

EXAMPLES OF RECURRENCE – STOPPED TREATMENT BEFORE MEDICAL ADVICE
Braces developed by Hajes
Dynamic Chest Compressor (DCC) and Adjustable DCC (ADCC)


• Manage pressure with lateral screws → can put pressure slowly: 1 turn in the screw make the anterior pad compress 1 mm
• No need to measure pressure with external applied devices.

ADCC (adjustable) 1 and 2 - project (2013)

I needed a brace that would be less dependent of a prosthetic
I have a lot of patients from others cities and countries.
The same PAD PATTERNS IN THE **DCC AND ADCC:**

**DCC 1X ADCC 1**
- Same type of posterior pads.
- Anterior pads of different patterns

**DCC 2X ADCC 2**
- Same types of anterior and posterior pads

---

**DCC X ADCC**

**(making it larger): patient growing and chest enlargement because of treatment**

- Ideal distance to the patient
- Telescopic bars allow doctor to do it in his office
- Need to send the brace to the prosthetic workshop or atelier
- Tight
May change pads position during treatment

For the best results you must see all the details...

DCC  X  ADCC
(changing the position of anterior pad)
Bone protuberance can change position during treatment because of pectus improvement or growing of the patient

To change position: new holes and rivets in prosthetic workshop
Possible to change position in doctors office
Changing lateral bar: must be done in prosthetic workshop

DCC       X       ADCC

(pressure: controlled by screw and lateral bar size)
Can increase or decrease pressure

Can change lateral bars in doctors office

DCC       X       ADCC

(measurements: detailed prescription of pads size, level and shape)

Cast mold

Caliper rule and flexible rule: faster and cleaner
Making measures for manufacturing the DCC – plaster caster mold with detailed prescription for pads level, size and shape

For customized DCC brace(s),

NO NEED FOR CAST MOLDS

Send the form by email to the prosthetic

Making measures for manufacturing the ADCC – rules / caliper rule or 3D SCAN

NO NEED FOR CAST MOLDS

Send the form by email to the prosthetic
Manufacturing and assembling in prosthetic workshop

Preestablished sizes of the anterior and posterior bars. Can assemble the brace in the office. Costs more? Depends if you can reuse bars and how much prosthetic charges for making adjustments in the DCC.

<table>
<thead>
<tr>
<th></th>
<th>DCC</th>
<th>ADCC</th>
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<tbody>
<tr>
<td>Possible to be assembled in the doctor’s office</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Cost</td>
<td>Low cost</td>
<td>Low cost, but higher than DCC</td>
</tr>
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ADJUSTABLE DCC I AND II

• ADCC: possibility to assemble the brace as you may have the anterior and posterior bars pre-manufactured
• may take measures of brace and start treatment in the same day.

Video 7
TREATMENT RESULTS: DCC X ADCC

- ADCC: initial research:
  - 17 patients used ADCC: mean follow-up of 14.4 months
  - DCC and ADCC same treatment results
  - ADCC: no need of a prosthetic to change or repair brace in the initial use and during treatment
  - ADCC: mean of 2 brace adjustments per patient - the same of the DCC (but needs a prosthetic)
  - after initial testing became the gold standard brace in our center.
RESULTS FOR ADCC

PEW – PECTUS EXCAVATUM WIDE

Mild pectus not in the growth spurt: less adjustments

RESULTS

PCI – PECTUS CARINATUM INFERIOR

1 lateral bar changed needed

11 months

EGD

January 2014 14 y

December 2014 15 y

6 months
FOR EVERY PECTUS THERE IS A POSSIBLE BRACE + EXERCICES TREATMENT

TREATMENT OF PCInferior
TREATMENT OF PCLateral
TREATMENT OF PCSuperior
TREATMENT OF PEWide
TREATMENT OF PELocalized

CHILDREN / ADOLESCENTS
ADULTS
TREATMENT OF PCI – INFERIOR TYPE

PCI – usually flexible deformity:
• Treatment in puberty: most of the cases
• Start treatment earlier: in childhood, when is a severe deformity

TREATMENT OF PCI – INFERIOR TYPE
Start treatment EARLIER in SEVERE CASES

2 YEARS OLD

AFTER 3 YEARS AND 3 MONTHS
Result after 10 months

Treat all the deformity components

Use DCC I and II for treating carinatum
Use DCC I and II for treating carinatum

Oct 15
16 y

HC

Oct 15

DCC I

4 months

Feb 16

DCC II

After 1 year treatment using only for sleeping time and exercises until skeletal maturity

July 2012
15 years

July 2013
TREATMENT OF PCI – INFERIOR TYPE

Less divergent breasts after PCI improvement

females

before

after
TREATMENT OF PCI – INFERIOR TYPE

IT IS POSSIBLE TO TREAT ADULTS

PRE

POST

POST

27 ye + 6 m

4 MONTHS

1 YE + 4 MO

From USA

DR Method: patients' compliance in different phases of life

TREATMENT OF PCL – LATERAL TYPE

PCL – usually flexible deformity, but a less then PCI;
• Treatment in puberty: most of the cases
• Start treatment earlier: in childhood, when is a severe deformity or when is a.....
TREATMENT OF PCL – LATERAL TYPE

Aug 2011

Oct 2013

9 years

38 MONTHS

..... is a girl start treatemnt earlier because you can not put pressure over the breast

TREATMENT OF PCL – LATERAL TYPE

CT IMPROVEMENT

PARTIAL CORRECTION OF HER BONE DEFORMITY, BUT SHE HAD ASSIMETRIC BREASTS ALSO

before

after

3-8-11

8-10-13
TREATMENT OF PCL – LATERAL TYPE

..... But if the breast are already developed you also may do the treatment for the lateral type

PCL – POSSIBLE TO TREAT ADULTS

AUGUST-2012

23 years

AUGUST-2013

Treat mild pectus

12 MONTHS

From USA
TREATMENT OF PCS – Superior type

PCS – rigid deformity;
• Start treatment earlier: in childhood, as soon as you make the diagnosis.
• The treatment is almost preventive.
• The x-ray and CT can help for an earlier diagnosis.

UNDERSTANDING WHY THE TREATMENT OF CURRARINO OR SUPERIOR TYPE IS ALMOST PREVENTIVE

X-RAY: STERNUM CAN BE SHORTER THAN REFERENCE VALUES

Haje SA, Harcke HT, Bowen JR, Pediatric Radiology, 1999

Premature closure or asymmetric growth of sternum growth plates can lead to deformity.

BM and BXM index

Normal BM / BXM = 2.16 (SD ±0.24)
Irregular manubrio-sternal junction

April 2001 – 3 ye + 8 mon

Only two sternal body segments

Fusion of the manubrio-sternal junction.
Look at the shape of the sternum.
The anterior angulation of the sternum got worse

Aug 2003 – 6 ye

Treatment indicated

TREATMENT OF PCS – Superior type

Db. 267-97

April 2013 – 15 ye + 10 mo

Came back after 10 years with a worse deformity and psychological problems.

TREATMENT OF PCS / CURRARINO DEFORMITY

Treatment was considered preventive and was indicated. Family was advised of the risk of these mild deformity of getting worse and RIGID.

Quit treatment after 3 months

Aug 2003 – 6 ye

32
PCS – what is the best conservative approach?

Early brace treatment (6 – 10 years of age) is also preventive, not only curative.

May 2010 – 6 ye + 4 mo

December 2015 – 11 ye + 11 mo

Started treatment 23 h/day

Using braces 18 hours/day

PCS – what is the best treatment?

Even it seems too late and it is a rigid type, try first the brace treatment. You still can have good results...

March 2010 – 12 ye + 5 mo

Sept 2012 – 14 ye + 11 mo
PCS – POSSIBLE TO TREAT ADULTS

Jan 2007 - Dec 2008

From Sweden

24 years

PCS – POSSIBLE TO TREAT ADULTS

Dec 2013 - March 2014

32 years
TREATMENT OF PEW – WIDE EXCAVATUM

PEW:
- Treatment as soon as you make the diagnosis
- Better results in patients using the brace 23 hours a day + exercises everyday
- Variable flexibility

Pectus excavatum - tendency to start treatment earlier

- Using only for sleeping time and exercises
- DCC and exercises

5 years

8 years
**Pectus excavatum** - better to use full time until skeletal maturity or full correction.

February 2015

November 2015

KEEP USING 23 HOURS A DAY

**Pectus excavatum** - Improvement showed by CT.

12 MONTHS
**Pectus excavatum** - weaning phase should be slower than carinatum

- **Nov 2011**: 12 years
- **May 2014**: 14 y + 6 m
- **August 2015**: 15 y + 11 m

- KEEP USING 23 HOURS A DAY
- STARTED THE WEANING

**Pectus excavatum** - treatment total time may be shorter in the end of adolescence

- **Sep 2010**: 15 y + 6 m
- **Jan 2013**: 17 y + 10 m

- 28 months follow-up: released from braces
PEW – POSSIBLE TO TREAT ADULTS

Bone can remodel !!!
Can have success for the flared ribs in some patients

Patient who received surgery before the Dynamic Remodeling (DR) method

Sweden, 3 years after DR method

20 years

TREATMENT OF PEL – LOCALIZED EXCAVATUM

PEL:
• Treatment as soon as you make the diagnosis
• Better results in patients using the brace 23 hours a day + exercises everyday
TREATMENT OF PEL – LOCALIZED EXCAVATUM

Feb 2008

May 2009

Aug 2013

10 years

5 years follow-up

1 year

July 2012

April 2014

DR Method: good results to pectus carinatum and pectus excavatum

15 y + 5 m

follow-up
Pectus excavatum - when the problem is more the flared ribs than the depression?

Best results than the ones with bigger depressions.

Aug 2012 - June 2013

13 y + 10 m

15 y + 5 m

19 MONTHS

PEL – partial result can avoid surgery

Patient willing to do surgery

Patient do not want surgery anymore
PEL – POSSIBLE TO TREAT ADULTS

Bone can remodel in some patients
Can have partial or total success in some patients

Jan 2000 – Sep 2000
8 MONTHS

49 years

PEL – POSSIBLE TO TREAT ADULTS

March 2013 – Nov 2013
8 MONTHS

20 years
PEL – partial initial result in adult
Can lead to better results in plastic surgery or Nuss.

21 years

COMPLICATIONS
- Skin problems – never need to stop treatment
- Bone edema: one case (adult)
- Overcorrection

Nov 2011

13 y + 9 m

FLARED RIBS OVERCORRECTED

July 2013

20 MONTHS
RESULTS – Haje’s method

Haje, Haje and Silva - 1977 - 2016
5791 - pectus patients
3338 - treated
2493 – RELIABLE DATA and treated with follow up > 12 months

Walmsley - 2011 - 2014
120 - pectus patients
82 – treated
12 – RELIABLE DATA and treated with follow up > 12 months
RESULTS

IMPROVEMENT:
3 – EXCELLENT OR GOOD (70-100%)
2 – MODERATE (40-70%)
1 – LITTLE (<40%)
0 - NO IMPROVEMENT

ANALYSE PATIENT SATISFACTION AT THE END OF TREATMENT.

PERSPECTIVE: 3D SCAN ANALYSIS PRÉ AND PÓS TREATMENT

RESULTS IN PATIENTS UNDER 19 YEARS OLD
– minimum follow-up of 1 year (1977-2016)

<table>
<thead>
<tr>
<th>Improvement</th>
<th>PCI</th>
<th>PCL</th>
<th>PCS</th>
<th>PEL</th>
<th>PEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM 3 e 2</td>
<td>77%</td>
<td>62%</td>
<td>42%</td>
<td>45%</td>
<td>39%</td>
</tr>
<tr>
<td>IM 1</td>
<td>13%</td>
<td>19%</td>
<td>42%</td>
<td>39%</td>
<td>42%</td>
</tr>
<tr>
<td>IM 0</td>
<td>10%</td>
<td>19%</td>
<td>16%</td>
<td>16%</td>
<td>19%</td>
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</tbody>
</table>

RESULTS IN moderate (F2) to very flexible (F3) pectus in patients with compliance

<table>
<thead>
<tr>
<th>Improvement</th>
<th>PCI</th>
<th>PCL</th>
<th>PCS</th>
<th>PEL</th>
<th>PEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM 3 e 2</td>
<td>92%</td>
<td>75%</td>
<td>-%</td>
<td>60%</td>
<td>70%</td>
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</table>
Association of Braces and Exercises to Vacuum Bell for the Treatment of Pectus Excavatum

HAJE, DP (2016): VACUUM BELL + BRACES + EXERCISES → 57% of pectus excavatum patients had good or excellent results (R2–R3) being most cases rigid (F0) to mild flexible (F1) excavatum.

See our poster presentation for more details

PEL – Haje’s method + vacuum bell

For patients with pectus excavatum that after few months of treatment shows that the depression component of the deformity have only partial results, we are associating in some cases the Vacuum Bell.
PEL – Haje’s method + vacuum bell

31 MONTHS

PEL – Haje’s method + vacuum bell
Concomitant orthotic treatment of Scoliosis, Hyperkyphosis and Chest Malformations

Davi P. Haje, MD, PhD
Moacir Silva Neto, MD
Sydney A. Haje, MD (in memoriam)

Centro Clínico ORTHOPECTUS
Hospital de Base do DF – SES – GDF

Brasília, DF, Brasil

Thoracic deformities

scoliosis

kyphosis

scoliosis with vertebral rotation = gibbosity

and pectus

CAN COEXIST
Posterior (SPINE) and anterior (STERNUM) chest wall are anatomically connected (by the RIBS and COSTAL CARTILAGES)!

Pectus deformities and Scolioses
Pectus deformities and Scolioses

Waters et al 21% of 596 patients with pectus that were operated presented scoliosis and needed orthosis or surgery.


Frick 4% to 5% of patients with pectus have scoliosis to warrant consultation and assessment by a spinal deformity specialist.


Haje SA and Haje DP (2009):

- Exacerbation of thoracic kyphosis was present in 14% of pectus cases.
- Scoliosis of 5° to 19° was detected 42% of pectus cases

What is the main problem of this patient?

Pectus Carinatum Inferior

Signs of SCOLIOSIS
Signs of SCOLIOSIS

CT: Latero-lateral asymmetry of sternum body shape

A study of vertebral rotation

Pedicles method

No asymmetry

Pedicle in the first segment

Pedicle in the second segment

Cobb angle

Metha angle

SCOLIOSES – RADIOLOGICAL STUDY

When to treat mild pectus + mild or moderate scoliosis (<20°) with the help of pectus braces?

- I treat all cases

Scoliosis risk of progression:

<table>
<thead>
<tr>
<th>Age</th>
<th>&lt;10°</th>
<th>20-29°</th>
<th>30-39°</th>
<th>&gt;40°</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12</td>
<td>25%</td>
<td>60%</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>13-15</td>
<td>10%</td>
<td>40%</td>
<td>70%</td>
<td>90%</td>
</tr>
<tr>
<td>16</td>
<td>0%</td>
<td>10%</td>
<td>30%</td>
<td>70%</td>
</tr>
</tbody>
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ORTHOTIC TREATMENT: **Dynamic Remodelling (DR) method**

Haje SH & Haje GP, International Orthopaedics, 2006

DR method: clinical benefits also on postural kyphosis and scoliosis signs

**BEFORE**  **AFTER**  **BEFORE**  **AFTER**

Patient treated with Dynamic Chest Compressor and exercises only

Patients with pectus deformity and mild scoliosis: treatment by DR method only

May 08  Oct 08  May 08  Oct 08
Adolescent with pectus and 18º scoliosis

AOA

7/7/09

14/1/10
Braces + exercises for pectus and spine/postural problems

KCM, 9 years

YMS, 15 years

Could this 9 years old girl with mild lateral pectus carinatum and very mild signs of scoliosis become this 15 year old girl with SEVERE scoliosis and assimetric trunk?

It is possible...

So let's treat her when she is 9....

Braces + exercises for pectus and spine/postural problems

km

August 14

9 years

March 15

7 months

Improved mild pectus carinatum lateral + mild hyperkyphosis and signs of scoliosis
When to treat scoliosis with the help of scoliosis braces?

- more than 20° of Cobb angle in the X-ray in growing subjects
  - but depending on the scoliosis curve is possible to treat some skeletally mature patients (controversial theme)
- Possible braces
  - Milwaukee
  - Boston
  - Charleston
  - Chaneau
  - Brasília

When you have pectus + hyperkyphosis and scoliosis treat before growth spurt

Braces + exercises for pectus, scoliosis and hyperkyphosis
Brasília Bending Brace (BBB)


**CONCOMITANT TREATMENT**

Four hours a day: DCC orthoses + one hour of DR method exercises, plus side bending and stretching exercises.
Rest of the time: BBB

<table>
<thead>
<tr>
<th>DCC</th>
<th>Brasilia Bending Brace</th>
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<tbody>
<tr>
<td>4h/day + exercises</td>
<td>19h/day</td>
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**BBB**: Plaster cast mold with corrective tilt made by the doctor
“When the spine is bent to one side, an automatic rotation of the vertebrae occurs to the same side.”

CONCOMITANT ORTHOTIC TREATMENT OF PECTUS DEFORMITIES AND MODERATE SCOLIOSIS
RESULT AFTER 60 MONTHS

Age 13+11
pre

Age 18+11
post
Another case: 20 years, PCI, 42° scoliosis + pectus carinatum inferior

Before

After

Treatment in a skeletally mature patient

Scoliosis + Pectus CONCLUSION

The spine lateral bending for scoliosis and the dynamic chest compression for pectus deformities show positive results, under an adequate medical protocol for compliant patients, justifying a continued investigation.

Haje SA, Haje DP, Martins GEV, Ferrer MG (2011), The spine lateral bending and the dynamic chest compression principles for concomitant orthotic treatment of scoliosis and pectus deformities, Coluna/Columna, 10(4): 293-9
ETIOLOGY of hyperkyphosis?

- Aseptic necrosis of the ring vertebral apophyses.
- Excess axial spine load due to heavy weight lifting.
- Hereditary predisposition.
- Sedentary lifestyle and muscles disbalance

Shy patients – not motivated for exercises
Weak paravertebral muscles
Flared ribs or pectus
Shortened pectoral muscles / anterior protrusion of shoulders
Weak abdominal muscles
Shortened hamstring muscles
Some pectus patients develop hyperkyphosis during adolescence because they want to hide the protusion or depression that is behind their shirt.

Children are not ashamed of their pectus condition as adolescents. Probably the kyphosis is because of weaker muscles or hereditary.
When to treat hyperkyphosis with the help of braces?

- not responding to kinesiotherapy
- clinically relevant
- > 45° of Cobb angle in the X-ray
- better in flexible cases
- can have or not signs of Scheuermann’s kyphosis (at least 3 adjacent vertebrae demonstrating wedging of >5 degrees)

When to treat hyperkyphosis with the help of braces?

- not responding to kinesiotherapy
- clinically relevant
- > 45° of Cob angle in the X-ray
- better in flexible cases
- can have or not signs of Scheuermann’s kyphosis (at least 3 adjacent vertebrae demonstrating wedging of >5 degrees)
How to treat hyperkyphosis and pectus together with brace?

- to treat kyphosis: in literature most of doctors use the:
  1) Milwaukee brace (apex > T9)
     - low compliance
     - do not correct shoulders
     - do not correct pectus or flared ribs

OR

2) TLSO (apex < T9)
   - do not correct shoulders
   - do not correct pectus or flared ribs

Brasilia Kyphosis Brace

- First brace described that can correct pectus + kyphosis
- developed in 2013 by Haje, DP
- can correct shoulders position, pectus and flaring ribs
- compliance looks better than Milwaukee
My braces possibilities to associate to specific exercises

Hyperkyphosis alone that failed other treatments

- Brasilia Kyphosis Brace making pressures in the flared ribs

Hyperkyphosis + pectus

- Pectus brace (DCC or ADCC)
- Pectus brace (DCC or ADCC) connected with shoulders straps
- Brasilia Kyphosis Brace (the point of pressure will depend on the pectus type)
Hyperkyphosis alone that failed other treatments

Brasília Kyphosis Brace making pressures in the flared ribs

ALTG
29-4-14
19-4-16
13y + 10 m

24 MONTHS
My braces possibilities to associate to specific exercises

Hyperkyphosis alone that failed other treatments

Hyperkyphosis + pectus

Brasília Kyphosis Brace making pressures in the flared ribs

Pectus brace (DCC or ADCC)

Pectus brace (DCC or ADCC) connected with shoulders straps

Brasília Kyphosis Brace (the point of pressure will depends on the pectus type)

Take these photos in the first appointment and ask the patient what photo he likes more

Tell the patient that he needs to strengthen and stretches his muscles and that the brace will help him to stay in the right position

May 2013
13 y + 6 m

One of the reasons that he stay in hyperkyphosis is because he is ashamed of his chest
When the chest starts getting better it helps to correct the hyperkyphosis because the patient is less ashamed.
May 2013 - in the beginning when asked to stay in the correct position

May 2015 - natural posture

24 MONTHS

Braces + exercises for pectus and hyperkyphosis

December 12
15 years

November 15
18 years

Natural

Natural

Trying to correct posture

Improved kyphosis and pectus

He keeps doing treatment because every year he is better

Trying to correct posture

Natural

Natural
My braces possibilities to associate to specific exercises

Hyperkyphosis alone that failed other treatments

Hyperkyphosis + pectus

Brasília Kyphosis Brace making pressures in the flared ribs

Pectus brace (DCC or ADCC)

Pectus brace (DCC or ADCC) connected with shoulders straps

Brasília Kyphosis Brace (the point of pressure will depend on the pectus type)

Treating hyperkyphosis + pectus together

Pectus brace (ADCC) connected with shoulders straps
My braces possibilities to associate to specific exercises

Hyperkyphosis alone that failed other treatments

Hyperkyphosis + pectus

Pectus brace (DCC or ADCC)

Pectus brace (DCC or ADCC) connected with shoulders straps

Brasília Kyphosis Brace (the point of pressure will depend on the pectus type)

Treating hyperkyphosis + pectus together with Brasilia’s Kyphosis Brace

Brasília Kyphosis Brace

- initial experience in 7 cases: good preliminary results
- All cases improved clinically
- Mean X-ray kyphosis angle 58.4º (pré) 52º (pós)
Treating hyperkyphosis + pectus together with Brasilia’s Kyphosis Brace

Pain because of a osteomyelitis

No pain

This lecture is dedicated to Sydney Abrão Haje, my father, pioneer of the non-surgical treatment of pectus deformities.
THANK YOU