

# Craniofacial distraction osteogenesis: the orthodontic perspective

**Language:** English

**Authors:** Dr. Christiane Treutlein<sup>1</sup>, Dr. Dr. Gwen Swennen<sup>2</sup>, PD Dr. Dr. Rupert Dempf<sup>2</sup>, Johannes Ludwig Berten<sup>1</sup>

<sup>1</sup>Medical School Hannover, Dept. of Orthodontics

<sup>2</sup>Department of Oral and Maxillofacial Surgery

**Date/Event/Venue:**

June 04-06. 2002

78th Congress of the European Orthodontic Society  
Sorrento, Italy

## Purpose

In this study the literature dealing with clinical and experimental craniofacial distraction osteogenesis (DO) was reviewed from an orthodontic perspective. The purpose of this review was two-fold: (1) to evaluate the different DO experimental animal models and (2) to evaluate clinical indications and DO parameters.

## Methods

A Pubmed search (NCBI, New Pubmed System) from 1966 through December 2000 was conducted. Key words applied in the search were distraction, orthodontics, lengthening, mandible, maxilla, midface, monobloc, cranial, craniofacial and maxillofacial. The experimental (revised 1 April 2001) and clinical (revised 3 April 2000) search revealed 120 and 109 articles, respectively. Flow sheets were made of each article with the specific parameters relative to DO and orthodontics

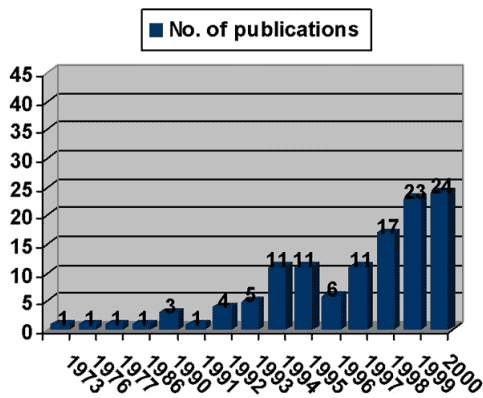


Fig. 1: Distribution of articles on experimental cranio-facial DO

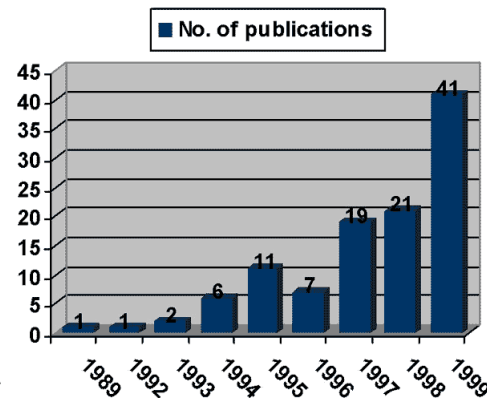


Fig. 2: Distribution of articles on clinical cranio-facial DO

## Results

### Experimental animal studies

A total of 1207 animals were used in seven different animal models: 54 (45.0 %) studies used dogs, 25 (20.8 %) rabbits, 18 (15.0 %) sheep, 11 (9.2 %) minipigs, 7 (5.8 %) monkeys, 4 (3.3 %) rats and 1 (0.8 %) a cat model. Only 3 (2.5 %) articles investigated on orthodontic tooth movement in the regenerate<sup>1,3,4</sup> and only 2 (1.7 %) on relaps.

		Latency	Distraction rate	Contention
<b>Mandibular lengthening</b>				
Rat	non-growing	5d	0,5/d	4w
Rabbit	non-growing	3-5d	1/d	4w
Dog	growing	?	?	?
	non-growing	7d	1/d	5-6w
Sheep	growing	5-7d	0,5-1/d	?
	non-growing	5-7d	1/d	?
	non-growing	5-7d	1/d	6w

Primate	growing	5-7d	0,9/d	6-8w
	non-growing	5-7d	1/d	6-8w

**Maxillary advancement**

Dog	growing	7d	1/d	6-8w
	non-growing	7d	1/d	6-8w
Primate	growing	7d	?	6-8w
	non-growing	?	?	?

**Midfacial advancement**

Dog	growing	7d	1/d	4-6w
	non-growing	7d	1/d	4-6w
Minipig	growing	2-4d	?	?
	non-growing	5-7d	1/d	6w

Table 1: Craniofacial DO parameters for different animal models

**Clinical Indications and DO parameters**

A total of 828 patients underwent craniofacial DO: 579 (70.0 %) mandibular, 129 (15.6 %) maxillary, 24 (2.9 %) simultaneous mandibular-maxillary, and 96 (11.6 %) midfacial and/or cranial DO. Only 479 patients (57.9 %) had data on follow-up and in only 248 patients (30,0 %) information on relaps was given.

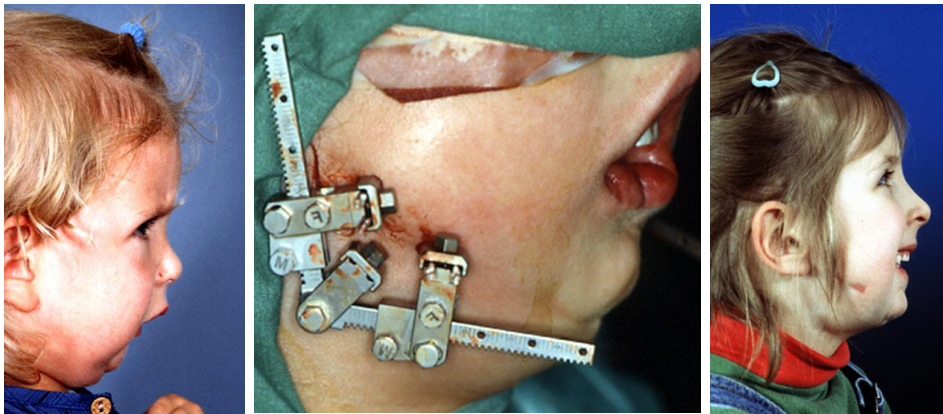


Fig. 3a-c: Patient with acquired mandibular micrognathia and an extraoral bidirectional distraction device before (a,b) and after distraction (c)

	Type of Surgery	Rate	Latency	Contention	Device
<b>Mandibular lengthening</b>					
<i>Mandibular micrognathia</i>					
<2/2-6/7-12/>16	Corticotomy	1/d	5-7d	6-8w	E I
	Osteotomy	1/d	5-7d	6-8w	E
<i>Mandibular retrognathia</i>					
>14 years	Body osteotomy	1/d	5-7d	6-8w	I
<b>Mandibular Widening</b>					
>12y	Symphyseal osteotomy	0,75-1/d	5-7d	6-8w	I
<b>Mandibular alveolar reconstruction</b>					
>16y	Segmental osteotomy	1/d	5-7d	8w	I
		0,5/d	5-7d	4-6m	I
<b>Mandibular bone transport</b>					
<i>TMJ reconstruction</i>					
>16y	Reverse-L osteotomy	1/d	5-7d	5-6w	E I
<i>Segmental defect reconstruction</i>					
>16y	Body osteotomy	1/d	10-12d	6-8w	E

Table 2: Treatment protocols for mandibular distraction osteogenesis



Fig. 4a-c: CLP-Patient with maxillary micrognathia before (a), during (b) and after (c) transpalatal distraction

	Type of Surgery	Rate	Latency	Contention	Device
<b>Maxillary advancement</b>					
5-13y	Incomplete Le Fort I	700/900g	4-5d	2-3m	Facial mask*
	Complete Le Fort I	700/900g	4-5d	2-3m	Facial mask*
13-16y	Complete Le Fort I	1/d	4-5d	2-4w**	RED
		1/d	4-5d	2-3m	I
	Complete Le Fort I	1/d	4-5d	2-4w**	RED
		1/d	4-5d	2-3m	I
>16y	Complete Le Fort I	1/d	4-5d	2-4w**	RED
		1/d	4-5d	2-3m	I
<b>Maxillary expansion</b>					
>14y	Incomplete Le Fort I***	0,33/d	5-7d	3-6m	I/bone
		0,25-1/d	5-7d	3-6m	I/tooth
<b>Maxillary alveolar reconstruction</b>					
>16y	Segmental osteotomy	1/d	5-7d	2m	I
		0,5/d	5-7d	4-6m	I°

Table 3: Treatment protocols for maxillary distraction osteogenesis



Fig. 5a-c: Patient with maxillary retrognathia (a), extraoral distraction device (b) and after maxillary advancement (c)

	Type of Surgery	Rate	Latency	Contention	Device
<4y	Monobloc	1/d	5-7d	2-3m	I/E
4-7/7-12/>12y	Le Fort III	1/d	5-7d	2-3m	I/E
		>1d	0d	6m	I
	Monobloc	1/d	5-7d	2-3m	I/E

Table 4: Treatment protocols for midfacial and/or cranial distraction osteogenesis

## Conclusions

On the basis of these results an attempt was done to provide guidelines for future experimental DO research, treatment protocols and success criteria for clinical craniofacial DO. There is still a lack of sufficient data, especially on orthodontic management<sup>2</sup>, dental-skeletal relaps and follow-up, so that treatment strategies have to be validated.

Criteria	%
1. Planned distraction distance is obtained	10

2. Planned distraction vector is obtained	10
3. No pseudoarthrosis	10
4. No nerve injury	10
5. No tooth damage	10
6. No persistent pain, discomfort or infection	10
7. No dentoalveolar compensations	10
8. Occlusal balance and adequate function	10
9. Patient satisfaction with esthetic and psychological outcome	10
10. Skeletal stability 1 year after the end of the contention period	10
	100

Table 5: Criteria of success of craniofacial distraction osteogenesis

## References

1. Cope J.B., Harper R.P., Samchukov M.L. Experimental tooth movement through regenerate alveolar bone: A pilot study. *Am J Orthod Dentofacial Orthop* 1999, 116, pp 501-505.
2. Hanson P.R., Melugin M.B. Orthodontic management of the patient undergoing mandibular distraction osteogenesis. *Semin Orthod* 1999, 5, pp 25-34.
3. Liou E.J., Figueroa A.A., Polley J.W. Rapid orthodontic tooth movement into newly distracted bone after mandibular distraction osteogenesis in a canine model. *Am J Orthod Dentofacial Orthop* 2000, 117, pp 391-398.
4. Liou E.J., Polley J.W., Figueroa A.A. Distraction osteogenesis: the effects of orthodontic tooth movement on distracted mandibular bone. *J Craniofac Surg* 1998, 114, pp 372-382.
5. Swennen G, Schliephake H, Dempf R, Schierle H, Malevez C. Craniofacial distraction osteogenesis: a review of the literature. Part 1: clinical studies. *Int J Oral Maxillofac Surg* 2001, 30, pp 89-103.
6. Swennen G, Schliephake H, Dempf R. Craniofacial distraction osteogenesis: a review of the literature. Part 2: experimental studies. *Int J Oral Maxillofac Surg* 2002, 31, pp 123-135.

## Abbreviations

DO: Distraction osteogenesis

*This Poster was submitted by Dr. Christiane Treutlein.*

## Correspondence address:

*Dr. Christiane Treutlein*  
 Medical School Hannover  
 Dept. of Orthodontics  
 Carl-Neuberg-Str. 1  
 D-30625 Hannover



## Craniofacial distraction osteogenesis: the orthodontic perspective

Swennen G. <sup>1</sup>, Treutlein C. <sup>2</sup>, Dempf R. <sup>1</sup>, Berten J.L. <sup>2</sup>

<sup>1</sup> Department of Oral and Maxillofacial Surgery (Head: Prof. Dr. Dr. J.-E. Hausamen)

<sup>2</sup> Department of Orthodontics (Head: Prof. Dr. R. Schweska-Polly)  
Hannover Medical School, Germany

### Purpose

In this study the literature dealing with clinical and experimental craniofacial distraction osteogenesis (DO) was reviewed from an orthodontic perspective. The purpose of this review was two-fold: (1) to evaluate the different DO experimental animal models and (2) to evaluate clinical indications and DO parameters.

### Methods

A Pubmed search (NCBI, New Pubmed System) from 1966 through December 2000 was conducted. Key words applied in the search were distraction, orthodontics, lengthening, mandible, maxilla, midface, monobloc, cranial, craniofacial and maxillofacial. The experimental (revised 1 April 2001) and clinical (revised 3 April 2000) search revealed 120 and 109 articles, respectively. Flow sheets were made of each article with the specific parameters relative to DO and orthodontics.

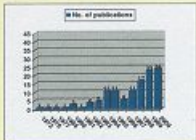


Fig. 1 Distribution of articles on experimental craniofacial DO

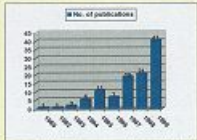


Fig. 2 Distribution of articles on clinical craniofacial DO

### Results

#### Experimental animal studies

A total of 1207 animals were used in seven different animal models: 54 (45.0 %) studies used dogs, 25 (20.8 %) rabbits, 18 (15.0 %) sheep, 11 (9.2 %) minipigs, 7 (5.8 %) monkeys, 4 (3.3 %) rats and 1 (0.8 %) a cat model. Only 3 (2.5 %) articles investigated on orthodontic tooth movement in the regenerate <sup>1,3,4</sup> and only 2 (1.7 %) on relaps.

Table 1 - Craniofacial DO parameters for different animal models.

Species	DO	Rate	Latency	Distraction rate	Duration
Dog	maxillary	50	0-10	0.5	10
	mandibular	50	0-10	0.5	10
	maxillary	50	0-10	0.5	10
Rabbit	maxillary	50	0-10	0.5	10
	mandibular	50	0-10	0.5	10
	maxillary	50	0-10	0.5	10
Sheep	maxillary	50	0-10	0.5	10
	mandibular	50	0-10	0.5	10
	maxillary	50	0-10	0.5	10
Minipig	maxillary	50	0-10	0.5	10
	mandibular	50	0-10	0.5	10
	maxillary	50	0-10	0.5	10
Monkey	maxillary	50	0-10	0.5	10
	mandibular	50	0-10	0.5	10
	maxillary	50	0-10	0.5	10
Cat	maxillary	50	0-10	0.5	10
	mandibular	50	0-10	0.5	10
	maxillary	50	0-10	0.5	10

#### Clinical Indications and DO parameters

A total of 828 patients underwent craniofacial DO: 579 (70.0 %) mandibular, 129 (15.6 %) maxillary, 24 (2.9 %) simultaneous mandibular-maxillary, and 96 (11.6 %) midfacial and/or cranial DO. Only 479 patients (57.9 %) had data on follow-up and in only 248 patients (30.0 %) information on relaps was given.

Fig. 3a-c Patient with acquired mandibular micrognathia and an external bidirectional distraction device before (a,b) and after distraction (c).



Table 2 - Treatment protocols for mandibular distraction osteogenesis.

Device	Type of Surgery	Rate	Latency	Distraction	Duration	
Mandibular lengthening	Mandibular distraction (2.5-3.12-1.6)	Collatony	100	5-70	0.5-1	1-2
		Osseotony	100	5-50	0.5-1	1-2
Mandibular elongation	1.8-2.0 mm	Endo osseotony	100	5-50	0.5-1	1
		Extracortical osseotony	4,15-100	5-50	0.5-1	1
Mandibular alveolar reconstruction	1.2-2.0 mm	Segmental osseotony	100	5-50	0.5-1	1
		Endo osseotony	100	5-50	0.5-1	1
Mandibular bone transport	TMJ reconstruction	External osseotony	100	5-50	0.5-1	1
		Endo osseotony	100	5-50	0.5-1	1
Segmental alveolar reconstruction	Endo osseotony	100	5-50	0.5-1	1	
		100	5-50	0.5-1	1	

Fig. 4a-c CLP-Patient with maxillary micrognathia before (a), during (b) and after (c) transpalatal distraction.



Table 3 - Treatment protocols for maxillary distraction osteogenesis.

Maxillary advancement	Type of Surgery	Rate	Latency	Distraction	Duration	
1-1.5 cm	Complex Le Fort I	Leopold	400	0-50	2-3 cm	Facial mask*
		Complex Le Fort I	700/1000	0-50	2-3 cm	Facial mask*
		10	0-50	2-3 cm	RFD	
1.5-3 cm	Complex Le Fort I	10	0-50	2-3 cm	1	
		10	0-50	2-3 cm	RFD	
		10	0-50	2-3 cm	RFD	
3-5 cm	Complex Le Fort I	10	0-50	2-3 cm	1	
		10	0-50	2-3 cm	1	
Maxillary expansion	1-1.5 cm	Complex Le Fort I**	0-200	0-50	3-5 cm	House
		0-200/10	0-50	3-5 cm	House	
Maxillary alveolar reconstruction	1-1.5 cm	Segmental osseotony	10	0-50	2-3 cm	1
		0-200	0-50	2-3 cm	1	

Fig. 5a-c Patient with maxillary micrognathia (a), external distraction device (b) and after maxillary advancement (c).



Table 4 - Treatment protocols for midfacial and/or cranial distraction osteogenesis.

Type of Surgery	Rate	Latency	Distraction	Duration	
1-1.5 cm	Monobloc	10	0-70	2-5 cm	10
1.5-3 cm	Le Fort II	10	0-70	2-5 cm	10
3-5 cm	Monobloc	10	0-70	2-5 cm	10

### Conclusions

On the basis of these results an attempt was done to provide guidelines for future experimental DO research, treatment protocols and success criteria for clinical craniofacial DO. There is still a lack of sufficient data, especially on orthodontic management <sup>2</sup>, dental-skeletal relaps and follow-up, so that treatment strategies have to be validated.

Table 5 - Criteria of success of craniofacial distraction osteogenesis.

Criteria	%
1. Planned distraction direction is obtained	100
2. Planned distraction vector is obtained	100
3. No postdistraction relaps	100
4. No nerve injury	100
5. No wound damage	100
6. No postdistraction dysfunction or infection	100
7. No dental/orofacial complications	100
8. Distraction failure and subsequent revision	100
9. Patient satisfaction with cosmetic and psychological outcome	100
10. Distraction stability 1 year after the end of the treatment - no postdistraction relaps	100

### References

1. Cline JH, Hager KP, Swennen G. Experimental tooth movement through segmental distraction. *J Oral Maxillofac Surg* 1995; 53: 21-25.
2. Swennen G, Treutlein C. Orthodontic management of the patient undergoing mandibular distraction osteogenesis. *Br J Orthod* 1998; 25: 25-30.
3. Swennen G, Treutlein C, Polley JH. Experimental tooth movement via early distraction of the mandible for maxillary expansion in a rat model. *Int J Orthod Craniofac Surg* 1998; 13: 20-25.
4. Swennen G, Treutlein C, Polley JH. Distraction osteogenesis: the effect of distraction on dental malocclusion. *Int J Orthod Craniofac Surg* 1998; 13: 26-30.
5. Swennen G, Treutlein C, Polley JH, Hausamen J, Swennen G. Craniofacial distraction osteogenesis: a review of the literature. Part I: Clinical studies. *Int J Orthod Craniofac Surg* 1998; 13: 31-35.
6. Swennen G, Treutlein C, Polley JH. Craniofacial distraction osteogenesis: a review of the literature. Part II: Experimental studies. *Int J Orthod Craniofac Surg* 1998; 13: 36-40.