International Poster Journal IPJ of Dentistry and Oral Medicine

Int Poster J Dent Oral Med 2003, Vol 5 No 01, Poster 165

Craniofacial distraction osteogenesis: the orthodontic perspective

Language: English

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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

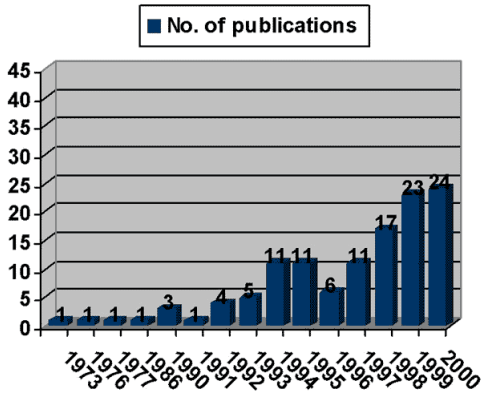

Fig. 1: Distribution of articles on experimental cranio-facial DO

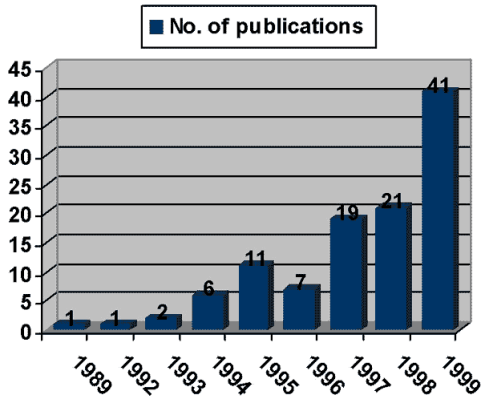

Fig. 2: Distribution of articles on clinical cranio-facial DO

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[1,3,4] and only 2 (1.7 %) on relaps.

		Latency	Distraction rate	Contention
Mandibular lengthening				
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.

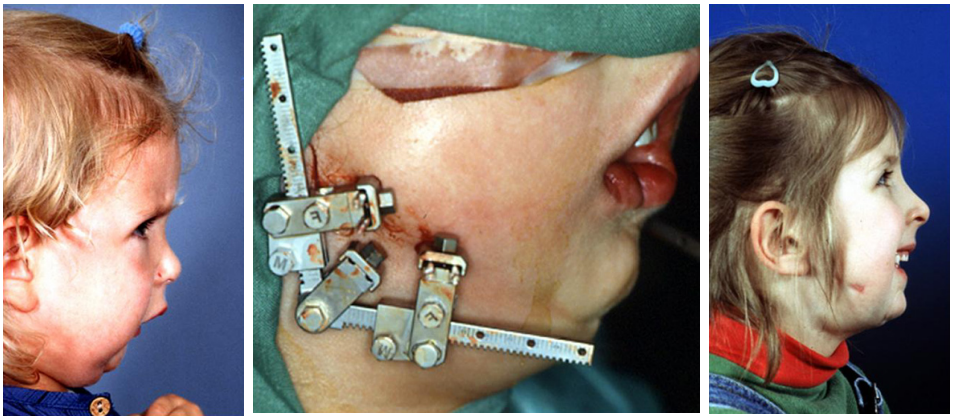

Fig. 3a-c: Patient with acquired mandibular micrognathia and an extraoral bidirectional distraction device before (a,b) and after distraction (c)

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

Table 2: Treatment protocols for mandibular distraction osteogenesis

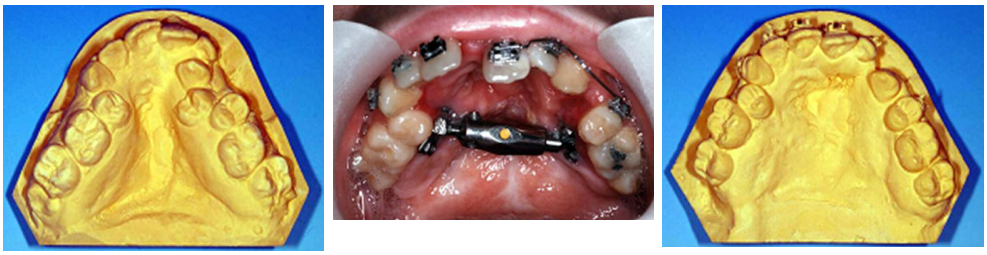

Fig. 4a-c: CLP-Patient with maxillary micrognathia before (a), during (b) and after (c) transpalatal distraction

	Type of Surgery	Rate	Latency	Contention	Device
Maxillary advancement					
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*
		1/d	4-5d	2-4w**	RED
		1/d	4-5d	2-3m	I
13-16y	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
Maxillary expansion					
>14y	Incomplete Le Fort I***	0,33/d	5-7d	3-6m	I/bone
		0,25-1/d	5-7d	3-6m	I/tooth
Maxillary alveolar reconstruction					
>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

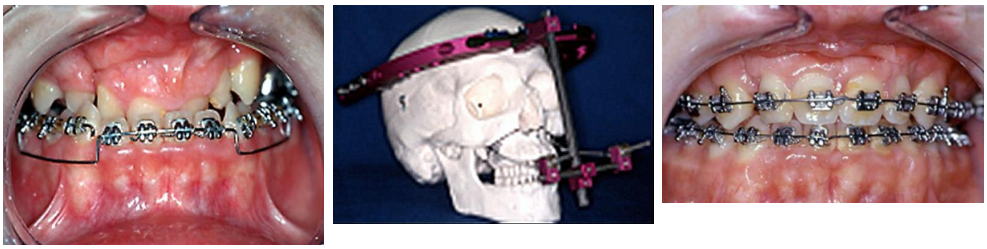

Fig. 5a-c: Patient with maxillary retrognathia (a), extraoral distraction device (b) and after maxillary advancement (c)

	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[2], 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 persistant 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

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Abbreviations

DO: Distraction osteogenesis

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