

P.o.POFF -- Plaster-of-Paris Off

(Via l'ingessatura)

CAST-OFF MODELLING FOR ARM FRACTURES

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Partners:

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- St. Mary's Hospital, Lacor, Gulu, Uganda
- l'Istituto di Biostrutture e Bioimmagini del Consiglio Nazionale delle Ricerche, Ing. Prof. Fabrizio Clemente
- Fondazione Piero e Lucille Corti, Milano
- Progetto GULUNAP – Università di Napoli Federico II

THE NEED

Fore-Arm fractures in children are very common at Lacor Hospital, especially in the mango season and all over the year. They are a constant overload to the staff of Lacor Hospital.

Dr.Ndayisaba Sylvester reports for the last 7 months, the following numbers, including fractures of the radius, ulna and humerus in children 1 yr to 15 years:

May 2018 - 34 fractures

June 2018- 32 fractures

July 2018- 30 fractures

August - 26

September- 30

October - 33

November - 31

December- 30

An estimated number of 340 arm fractures are cared for at Lacor in one year.

These are actually treated with the traditional Plaster-of-Paris Cast for 4-6 weeks. Unfortunately, this treatment is demanding for the staff, but it is often a source of problems for the treated child. It is often impossible to apply the plaster in the early days of the fracture, because of inflammation. More than one cast/child is frequently needed. It limits his mobility, is susceptible to water, reduce its fitness to the arm over time, since the inside cotton wool is compressed, it is not reusable. Rehabilitation after cast removal is frequently required.

OBJECTIVE

To develop a series of pre-printed ready-for-use 3D light plastic casts to manage arm fractures in children.

PHASE 0

Training for the best use of the scanner

- Two operators are trained to the use of scanner by scanning at least 10 arms of voluntary
- They are trained to use the scanner software on a LapTop
- Then they scan 10 voluntary children' arms at the Santobono site
- An evaluation of skill and performance is done before the mission

COMPLETED: February 8th 2019

PHASE 1: Lacor, Gulu, Uganda

Estimating a series of parameters of arm dimensions in school-age children

- 40 males and 40 females at age 6, 7, 8, 9, 10,11,12
- Obtaining Length
 - o Length of forearm+ hand
 - o length of Ulna, (from epicondyle to ulna styloid process)
 - o circumferences of:
 - o hand (at distal metacarpal junction)
 - o Wrist (at radio-ulnar metaphysis)
 - o Mid-Arm (mid of acromion-olecranon points length)
 - o Elbow

DONE February 27th 2019: 82 children from St. Jude's Primary School, Lacor, Gulu, Uganda (Manager Br. Elio Croce), aged 5-12 years of age, both sexes, have been scanned at the left and right arm, several times for a total of 320 scans.

PHASE 2: Naples

Development of 3D parameters of forearm for each age and sex, mean, median, percentiles
Estimation of the relationship with body anthropometry.

Outcome expected: for each age and ulnar length estimate the 25th, 50th and 75th centiles of hand, wrist, mid-arm and elbow circumferences.

ONGOING. March 2nd 2019: Percentile of arm circumferences by ulnar length have been developed.

Revised parameters of the 82 children were examined by SPSS Ver.21 and EXCEL to get the required estimates.

RESULTS:

1. Sex (M/F) and Side of the arm (Left/Right) are not correlated to the listed circumferences, neither to the ulnar length. Pearson Correlation Coefficient ranges from 0,01 to -0,1 not significant. Hence data were pooled independently by sex and side.
2. AGE is poorly related to length. Since no child knew his birth date and age is assigned by school level 6-7-etc with the assumption that this corresponds to the actual age of the subject. No identity card. The corrcoeff. For hand, wrist, midarm and elbow with age are

,616**	,434**	,411**	,468**
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3. Height is related to the circumferences, but it is unlikely to be available or actually measured in the emergency department, to which the fracture child is referred.
4. Ulnar length is well correlated to the circumference and its measure is simple and mandatory when the fractured child is accepted. The corrcoeff. For hand, wrist, midarm and elbow with age are

,700**	,544**	,455**	,539**
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All better than with age.

5. We then propose to select the 10th, 25th, 50th, 75th and 90th centiles of the circumferences of hand, wrist, mid-arm and elbow corresponding to the Ulnar length of 5 classes 17-18, 19-20, 21-22, 23-24 cm.
6. The Table II shows the values of the circumferences by each ulnar length (vertical axis) and by the centiles of circumferences from 10th to 90th (horizontal axis)

	Ulna.cm/2	10	25	50	75	90
Hand	18	13,080	14,200	15,500	16,050	16,360
	20	14,600	15,050	16,000	16,650	17,050
	22	16,000	16,350	16,800	17,450	18,550
	24	16,300	17,200	17,900	18,200	18,680
Wrist	18	11,280	11,950	12,700	13,150	13,400
	20	12,500	12,650	13,200	13,575	14,600
	22	12,950	13,200	13,550	14,100	15,400
	24	13,080	13,800	14,200	14,700	14,980
MidArm	18	13,360	14,250	14,800	15,600	18,020
	20	13,550	15,000	15,700	16,675	18,250
	22	14,500	15,500	16,000	17,575	18,550
	24	15,900	16,700	17,200	18,200	19,040
Elbow	18	15,200	16,050	17,000	18,250	19,280
	20	17,400	17,825	18,600	19,525	20,400
	22	18,000	18,575	19,150	20,375	22,100
	24	18,560	19,300	20,500	21,050	22,860

It may be noted that if we print a cast with and hand circumferences of 16 cm, this is a good fit at 50th centile for the child with an ulnar length of 20 cm, but it is also adequate for a child with an ulnar length of 18 cm at the 90th centile (right), and also for a child with an ulnar length of 24 cm at the 10th centile (at left).

So the same cast might be adapted to several children with different ulnar length and different development within the same class of ulnar length.

The same applies for Wrist circ., where a circum of 13,2 cm might be fitted to children with ulnar length of 18,20, 22 and 24 cm with different development.

Idem for Mid-Arm and elbow.

- PHASE 3: Naples
- Developing 4 sets of models of 3D plastic casts suitable for the 25TH, 50TH and 75TH centiles of ulnar length 18,20,22,24 cm (3 centiles classes x 4 ulnar lengths = 12 cast in each set). A total of 48 cast might be printed in the first lot.
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- PHASE 4: Lacor, Gulu, Uganda
- Evaluation, in vivo, of the adaptability of the models to groups of healthy and fractured children, also using small strip of suitable rubber in critical points.
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- Possible ---- PHASE 5: Buccino, Salerno
- Printing several dozens of models by industrial plastic printing by 3D steel models

PHASE 6: Lacor, Gulu, Uganda

Evaluating the mid-term efficacy of the intervention and planning the transfer of the full 3D printing technology to Lacor.

TIMING :

The project should reach Phase 6 within 3 months from start.

RESOURCES

Fondazione Santobono and Gulunap Project will support CAST-Off, no cost for Lacor.

Table I : Correlation coefficients between variables

		PearsonCorrelationCoefficients								
		Side	years	Sex	Height	Ulna	Hand	Wrist	MidArm	Elbow
Side	r	1	,117	,051	,107	,031	-,091	,047	-,014	-,125
	p		,293	,651	,337	,782	,416	,677	,897	,262
	N	82	82	82	82	82	82	82	82	82
Years	r	,117	1	-,044	,857	,771	,616	,434	,411	,468
	p	,293		,692	,000	,000	,000	,000	,000	,000
	N	82	82	82	82	82	82	82	82	82
Sex	r	,051	-,044	1	-,003	-,048	-,099	-,095	,145	-,061
	p	,651	,692		,979	,669	,377	,395	,192	,586
	N	82	82	82	82	82	82	82	82	82
Height	r	,107	,857	-,003	1	,860	,719	,531	,515	,543
	p	,337	,000	,979		,000	,000	,000	,000	,000
	N	82	82	82	82	82	82	82	82	82
Ulna	r	,031	,771	-,048	,860	1	,700	,544	,455	,539
	p	,782	,000	,669	,000		,000	,000	,000	,000
	N	82	82	82	82	82	82	82	82	82
Hand	r	-,091	,616	-,099	,719	,700	1	,664	,694	,680
	p	,416	,000	,377	,000	,000		,000	,000	,000
	N	82	82	82	82	82	82	82	82	82
Wrist	r	,047	,434	-,095	,531	,544	,664	1	,408	,547
	p	,677	,000	,395	,000	,000	,000		,000	,000
	N	82	82	82	82	82	82	82	82	82
MidArm	r	-,014	,411	,145	,515	,455	,694	,408	1	,576
	p	,897	,000	,192	,000	,000	,000	,000		,000
	N	82	82	82	82	82	82	82	82	82
Elbow	r	-,125	,468	-,061	,543	,539	,680	,547	,576	1
	p	,262	,000	,586	,000	,000	,000	,000	,000	
	N	82	82	82	82	82	82	82	82	82

** . La correlazione è significativa al livello 0,01 (2-code).



