Groupe d'Etude du Pied et de la Marche
G E P M

Rencontres pluridisciplinaires de Briançon
27,28 et 29 mars 2009

Place de l'analyse baropodométrique avant et après chirurgie du pied plat

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Pied plat valgus

Définition statique

Le bilan clinique & radiographique en charge

Face

↓

abduction

Profil

↓

affaissement

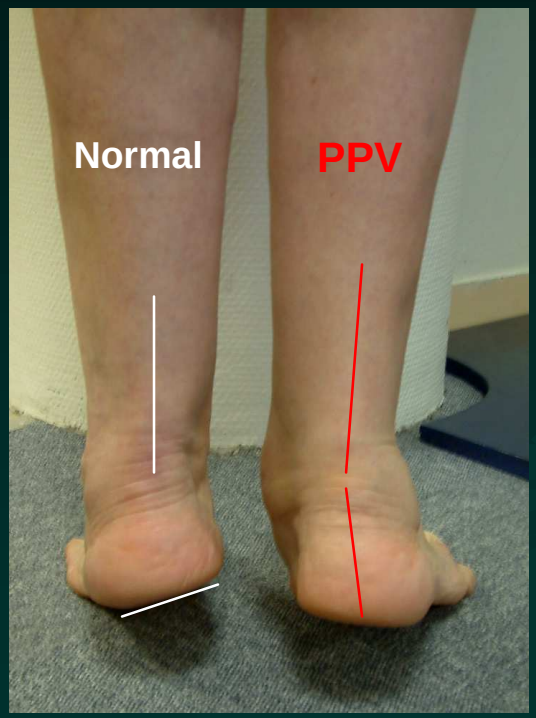
Méary

↓

valgus

Pied plat valgus Définition dynamique

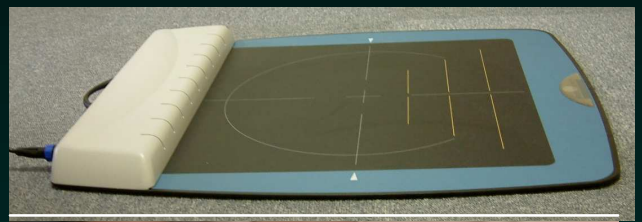
Défaut de verrouillage du pied
= marche apropulsive *(Meehan – Foot ankle clinics sept 2005)*

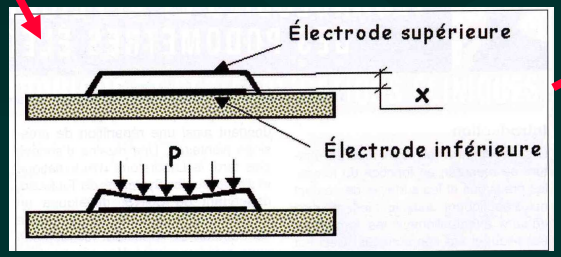


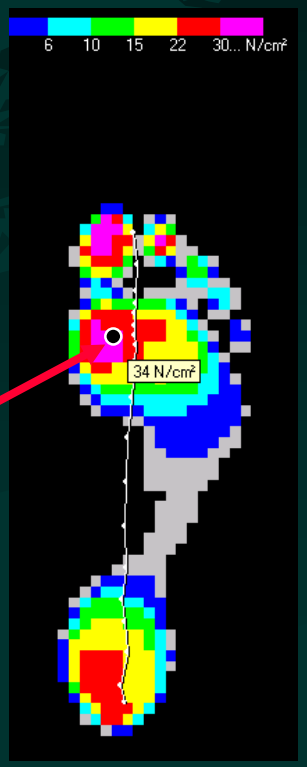
pointe bipodal

pointe monopodal

<u>Principe</u> du capteur de force
= convertir la pression en tension électrique



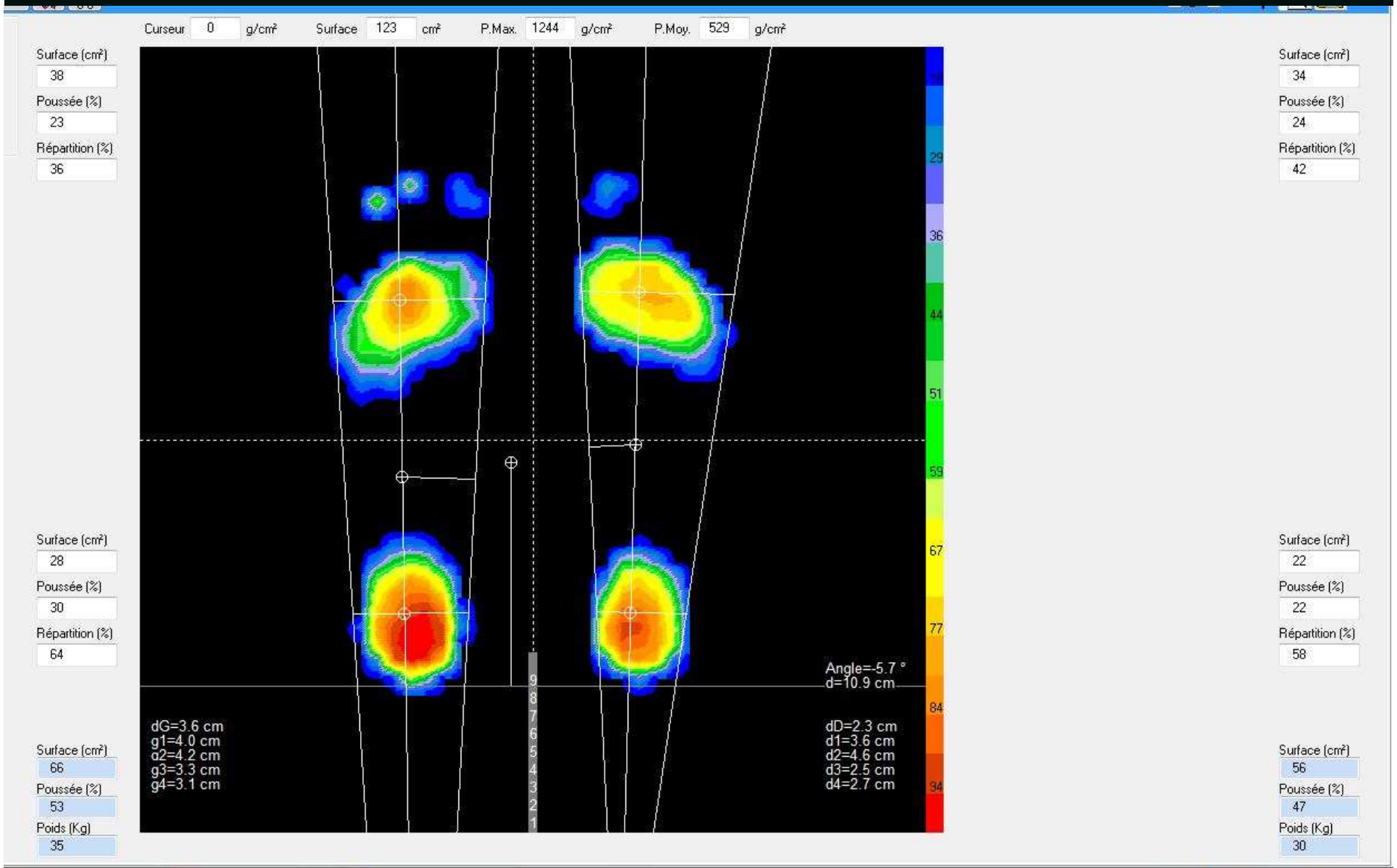


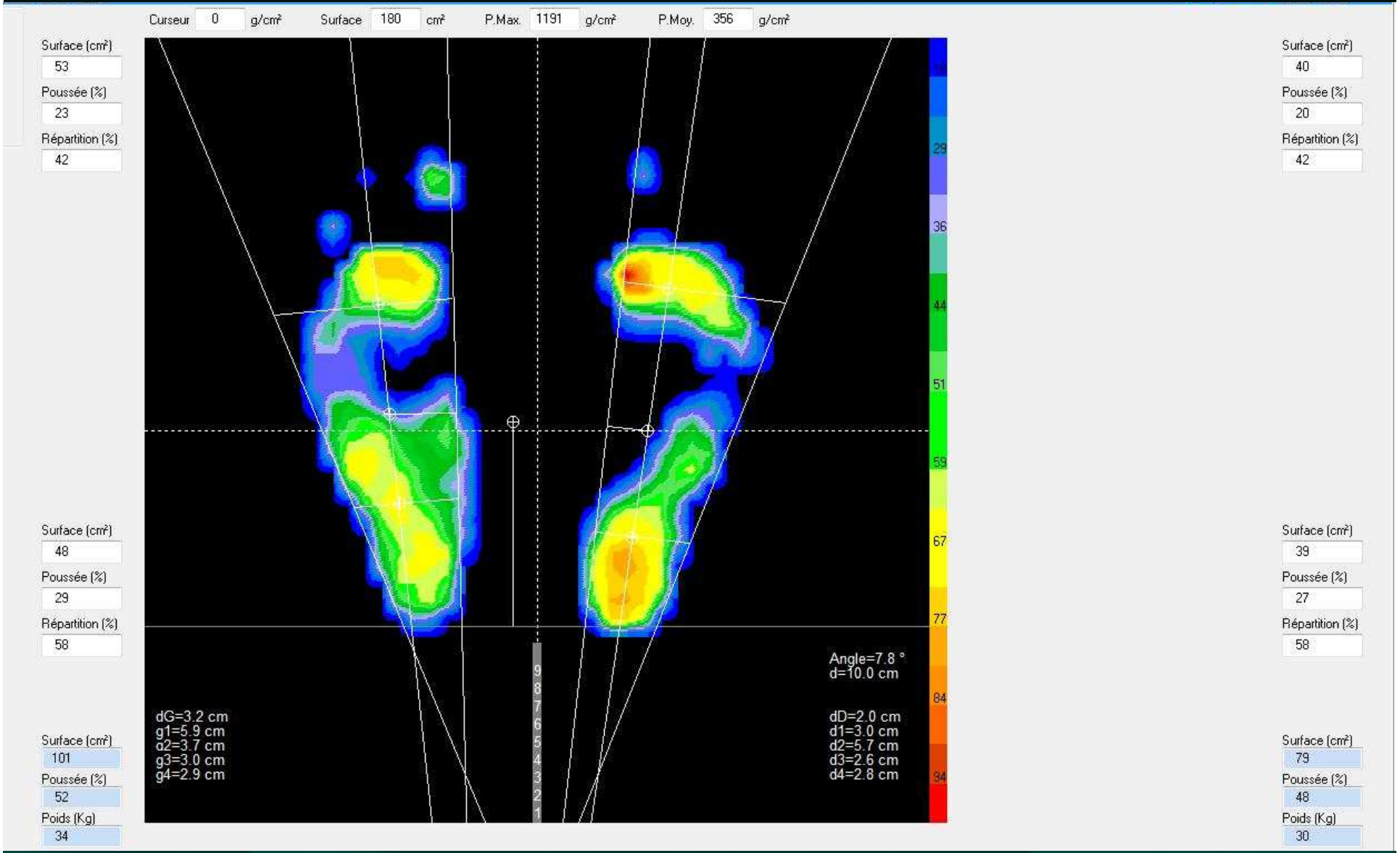


capteurs (capacitifs ou résistifs)

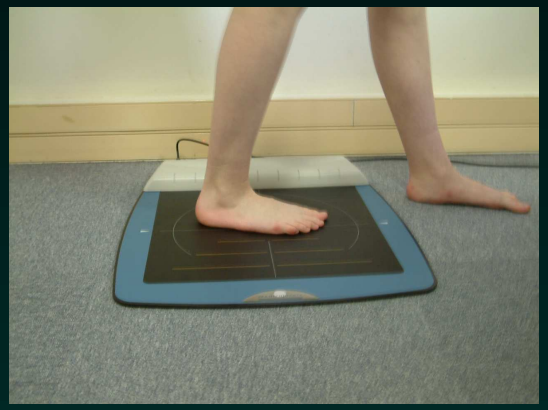
Mesure sur ordinateur

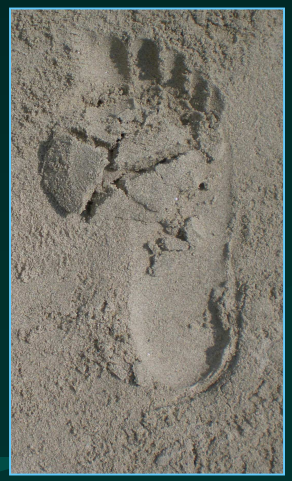
1 – la baropodométrie statique


Curseur 0 g/cm²
Surface 123 cm²
P.Max. 1244 g/cm²
P.Moy. 529 g/cm²
Surface (cm²) 38
Poussée (%) 23
Répartition (%) 36
Surface (cm²) 34
Poussée (%) 24
Répartition (%) 42
Surface (cm²) 28
Poussée (%) 30
Répartition (%) 64
Surface (cm²) 22
Poussée (%) 22
Répartition (%) 58
Surface (cm²) 66
Poussée (%) 53
Poids (Kg) 35
Surface (cm²) 56
Poussée (%) 47
Poids (Kg) 30
29
36
44
51
59
67
77
84
94
Angle=-5.7 °
d=10.9 cm
dG=3.6 cm
g1=4.0 cm
g2=4.2 cm
g3=3.3 cm
g4=3.1 cm
dD=2.3 cm
d1=3.6 cm
d2=4.6 cm
d3=2.5 cm
d4=2.7 cm


Curseur 0 g/cm²
Surface 180 cm²
P.Max. 1191 g/cm²
P.Moy. 356 g/cm²
Surface (cm²) 53
Poussée (%) 23
Répartition (%) 42
Surface (cm²) 48
Poussée (%) 29
Répartition (%) 58
Surface (cm²) 101
Poussée (%) 52
Poids (Kg) 34
Surface (cm²) 40
Poussée (%) 20
Répartition (%) 42
Surface (cm²) 39
Poussée (%) 27
Répartition (%) 58
Surface (cm²) 79
Poussée (%) 48
Poids (Kg) 30
dG=3.2 cm
g1=5.9 cm
g2=3.7 cm
g3=3.0 cm
g4=2.9 cm
Angle=7.8 °
d=10.0 cm
dD=2.0 cm
d1=3.0 cm
d2=5.7 cm
d3=2.6 cm
d4=2.8 cm
29
36
44
51
59
67
77
84
94

2 – la baropodométrie dynamique





Méthodologie = rigoureuse ++

Piste de marche avec Emed-SF

marche aussi normale que possible =

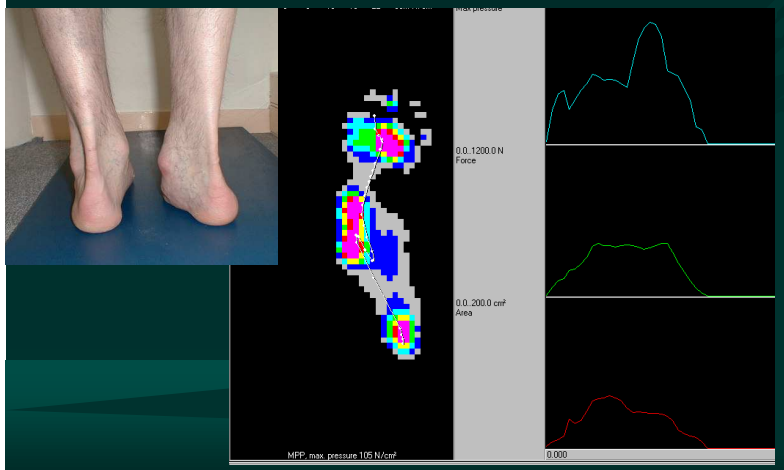
- essais préalables (au moins 2)
- analyse du second pas ou 5 pas en moyenne avant pour certains (= vitesse établie) = piste de 10 mètres
- ne conserver que les pas « normaux »
- capteurs au niveau de la piste

Nécessité de plusieurs passages : 3 à 5 / pied = reproductibilité

Problèmes rencontrés dans le pied plat

Rotation externe du pied incompatible avec L'étroitesse de la plateforme :
le patient est tenté de réaxer son pied !

Difficultés de marche : analyse du 1er pas



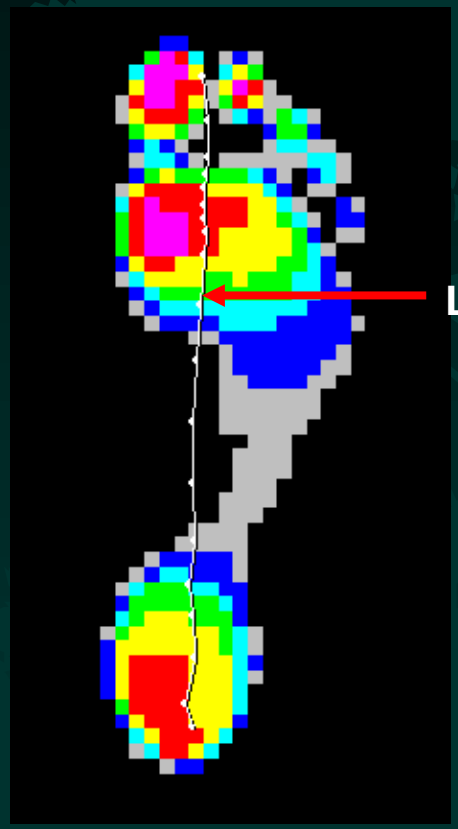
Mauvaise reconnaissance du côté
Ici , côté droit

FRANCES ANDRE

Le résultat normal

pression : 4 capteurs/cm²

- 0 à 1 N/cm²
- 1 à 3 N/cm²
- 3 à 6 N/cm²
- 6 à 10 N/cm²
- 10 à 15 N/cm²
- 15 à 22 N/cm²
- 22 à 30 N/cm²
- > 30N/cm²

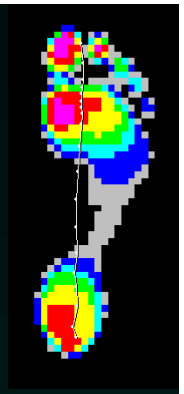


Empreinte normale

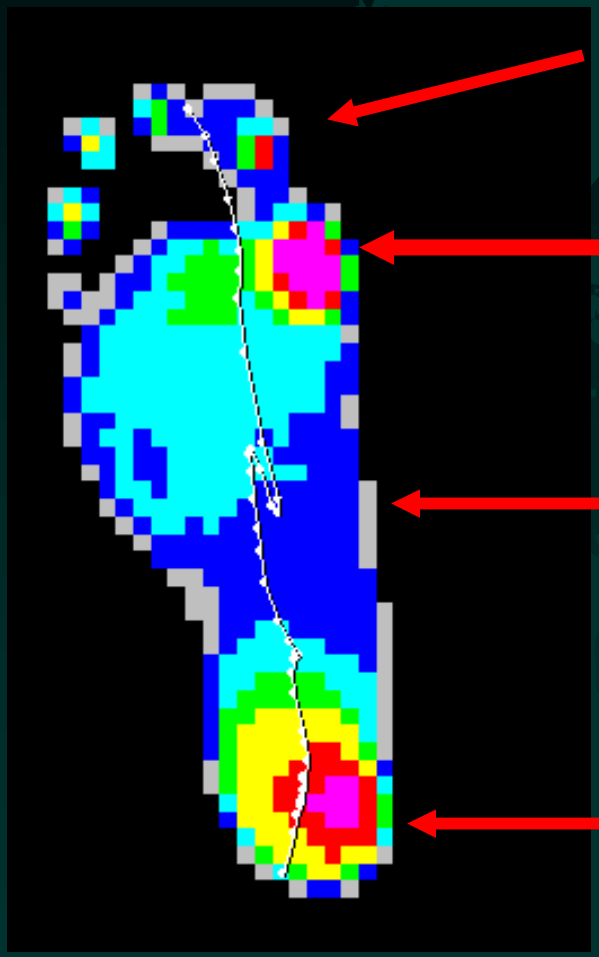
Ligne des centres de pressions

= synthèse d'images dynamiques

Facteurs baropodométrique du pied plat



Pas de critères constants



Hallux valgus (40%)

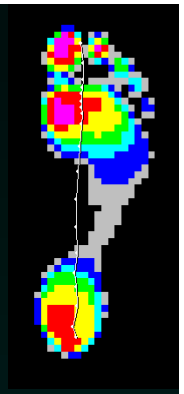
Hyper-appui
Sous tête M1 +++ (70%)

Médio-pied large (60%)

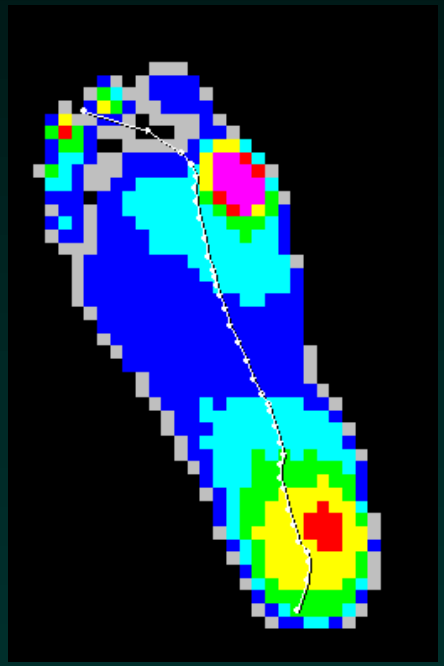
abduction
Avant-pied
(60%)

Valgus arrière-pied (70%)

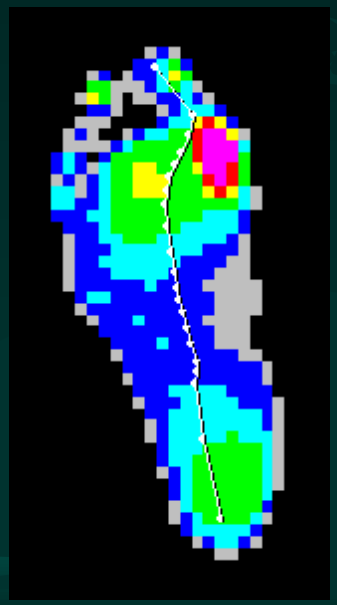
Facteurs baropodométrique du pied plat



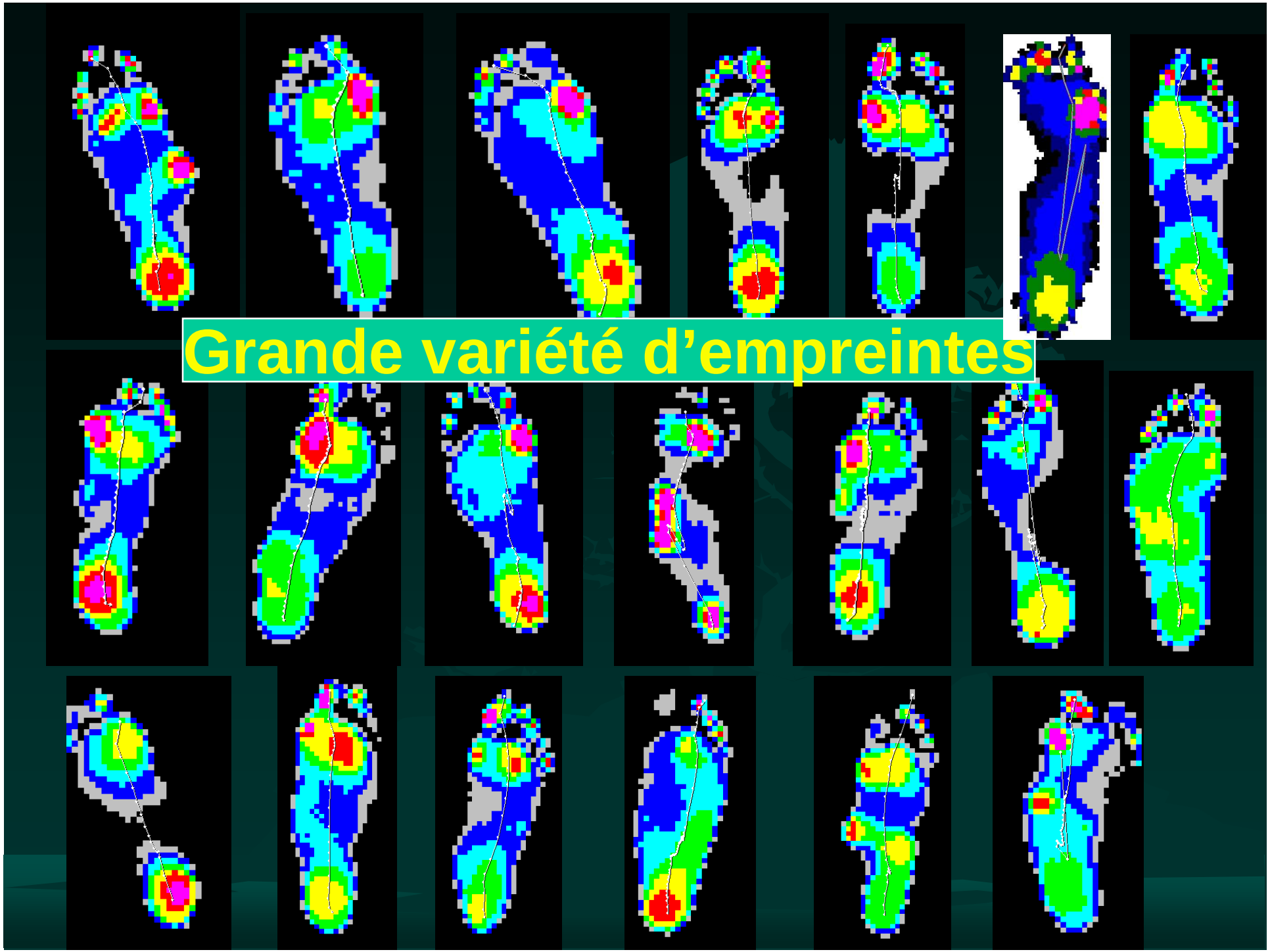
Avant-pied



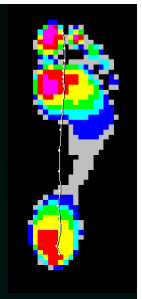
Hyper-pression sous tête M1
jamais douloureux
Grâce à l'affaissement de l'arche médiale

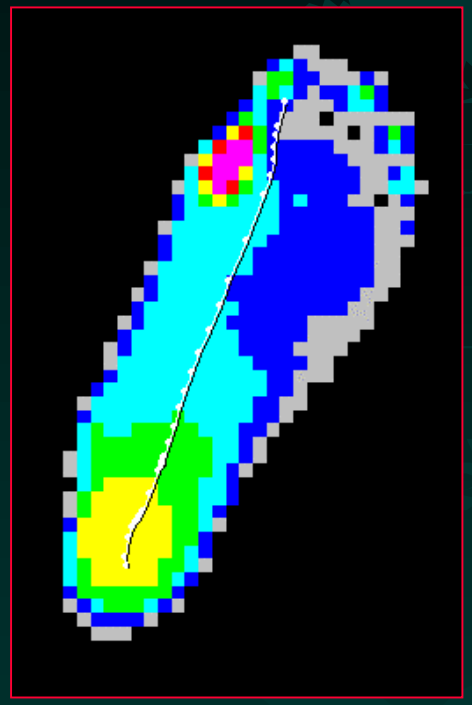


Hallux valgus
Pas bien défini sur le plan géométrique
= on ne peut pas le mesurer

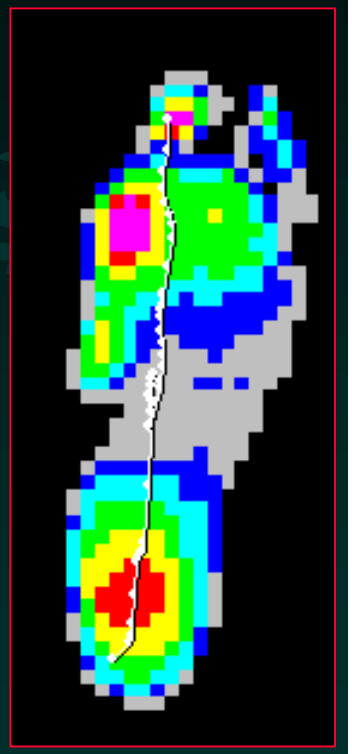

Grande variété d’empreintes

La baropodométrie dynamique dans pied plat valgus





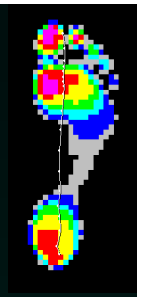
Pied plat abductus
(Too much toes)



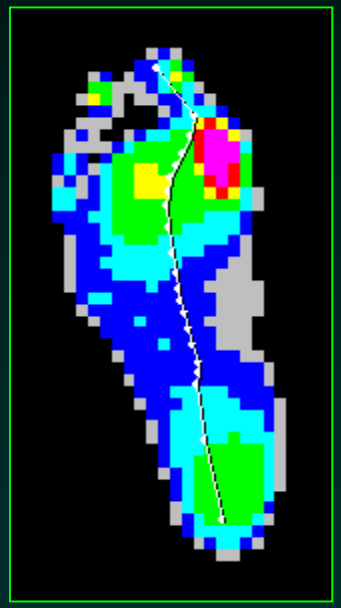
Pied plat valgus

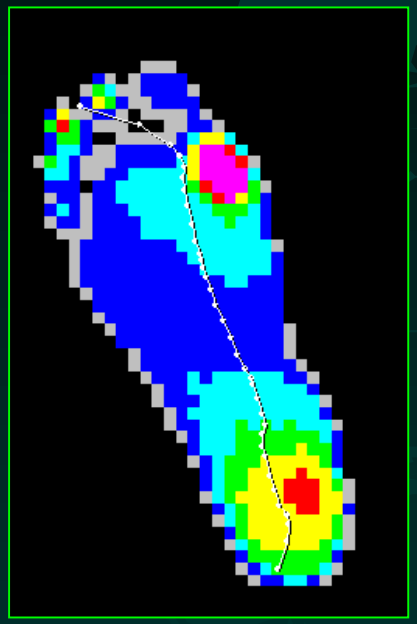
Classification de Toullec

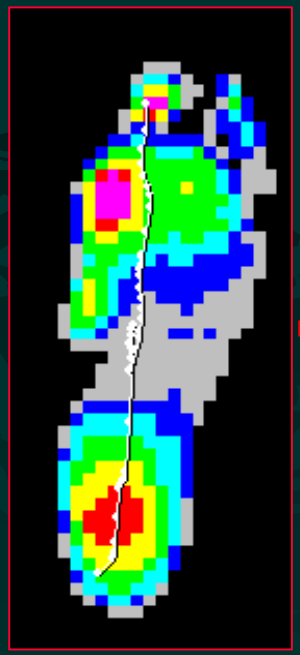
La baropodométrie dynamique dans pied plat valgus

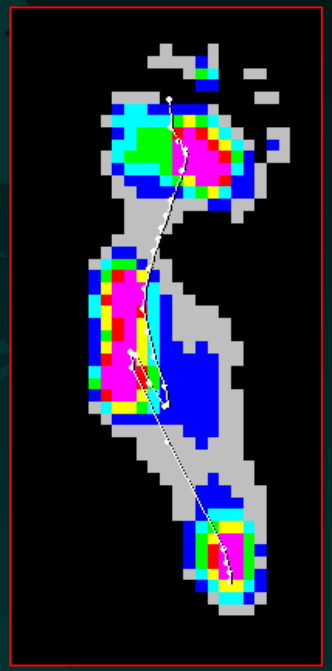


Différent stades





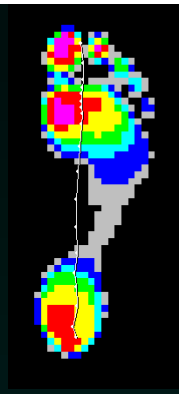




Pied plat abductus
(Too much toes)

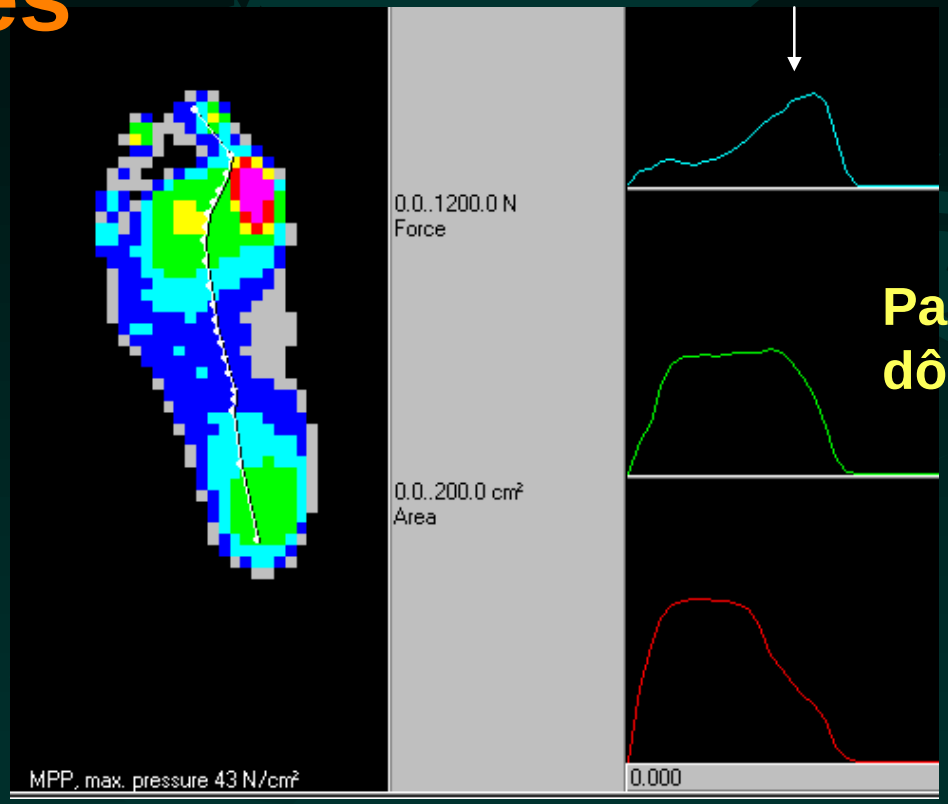
Pied plat valgus

Facteurs baropodométriques du pied plat



1-Les courbes

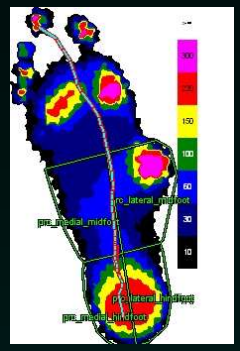
Hyper-pression au lever du talon



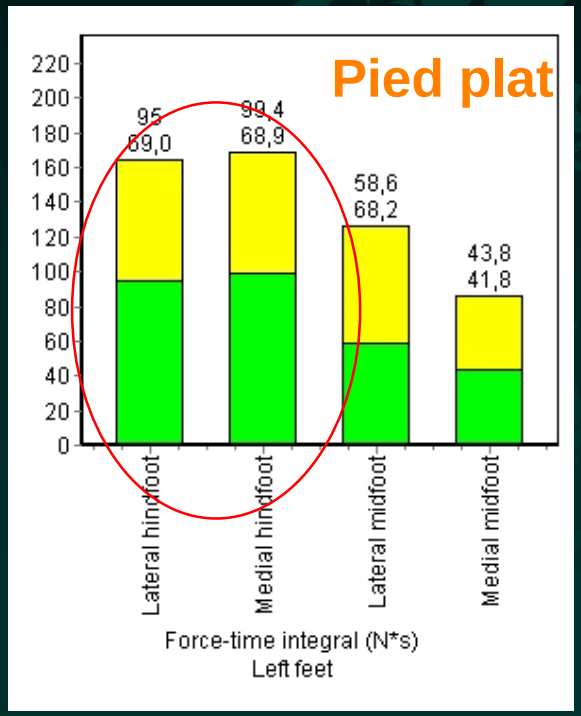
Pas de double dôme

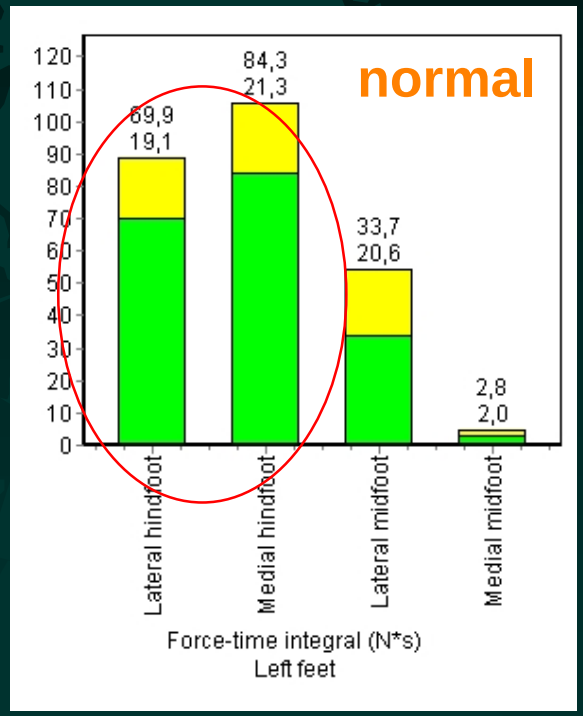
Aire d'appui plus importante et durant plus de temps

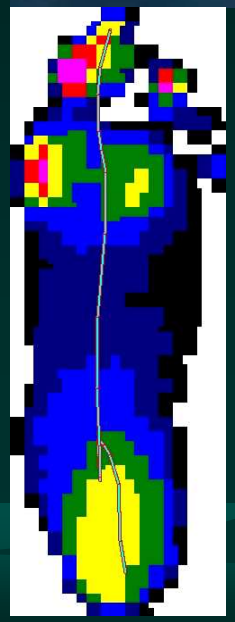
Facteurs baropodométriques du pied plat



2- Les masques

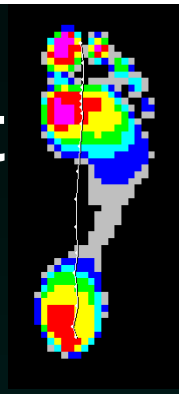






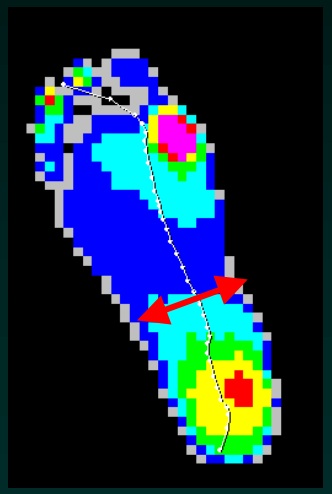
Moyenne intégrale force temps côté gauche dans notre série comparé au normal (ESM 2004)

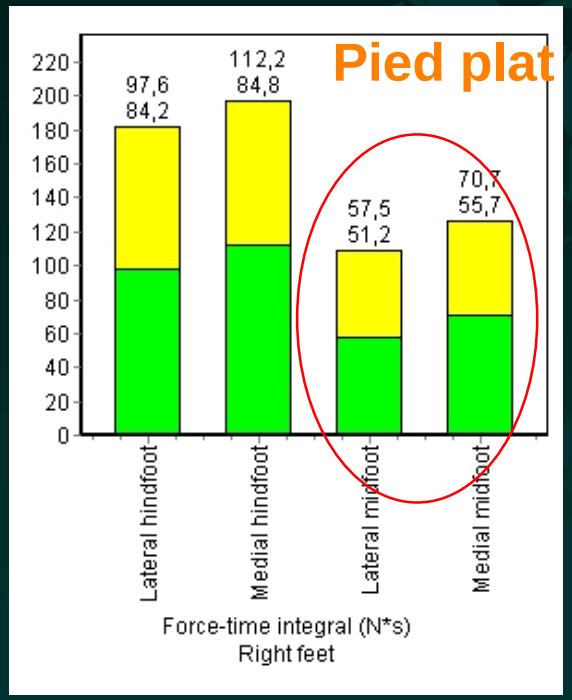
Facteurs baropodométriques du pied plat

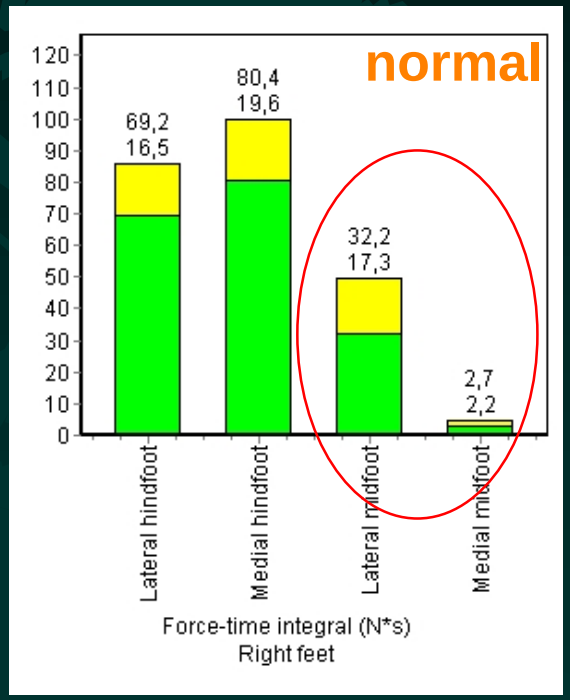


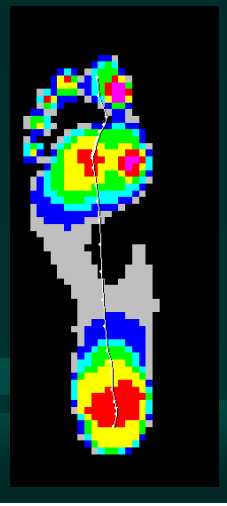
Médio-pied

Large sauf si le valgus est la déformation principale









Moyenne intégrale force-temps côté droit

3 – index de force latéro-médiale

LAMFI =

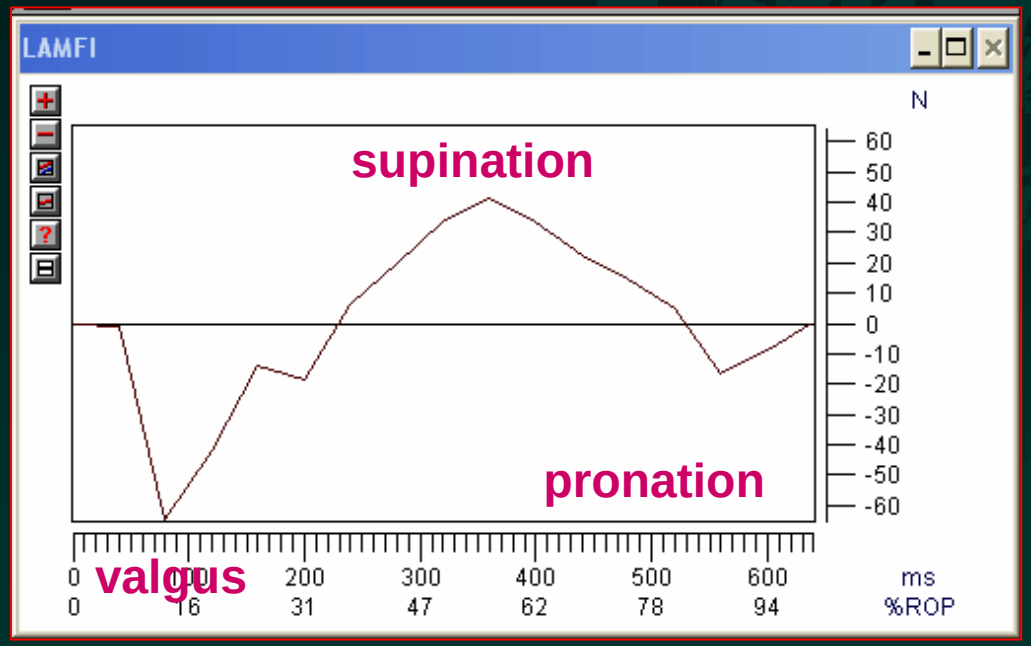
(lateral medial force index)

$$\frac{\text{intégrale force temps latérale}}{\text{intégrale force temps médiale}}$$

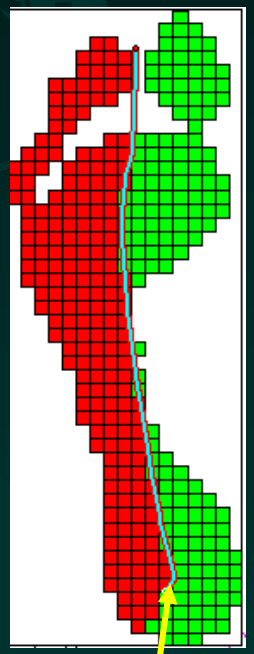
→ **Temps++**

Force latérale

Force médiale

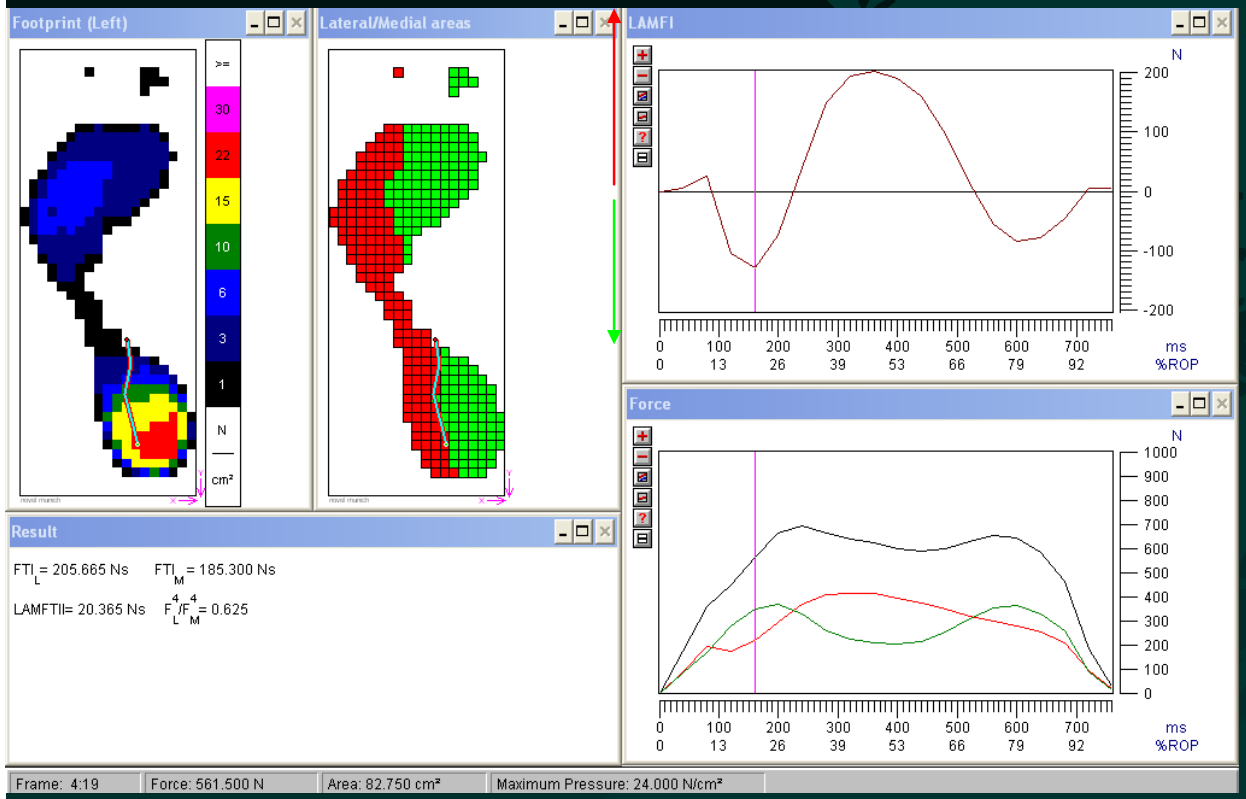


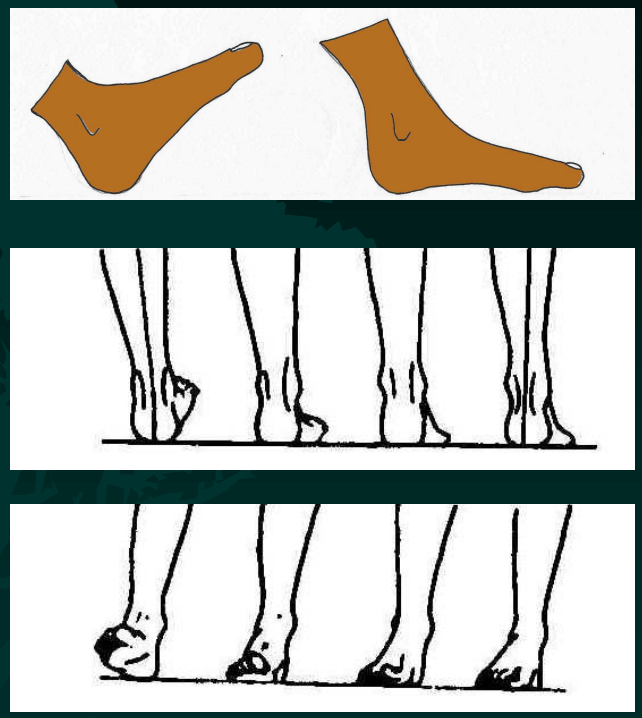
Courbe d'un pied normal



COP

Appui talonnier



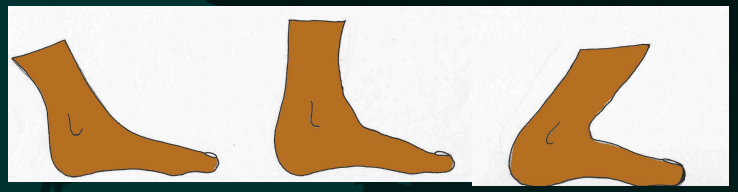


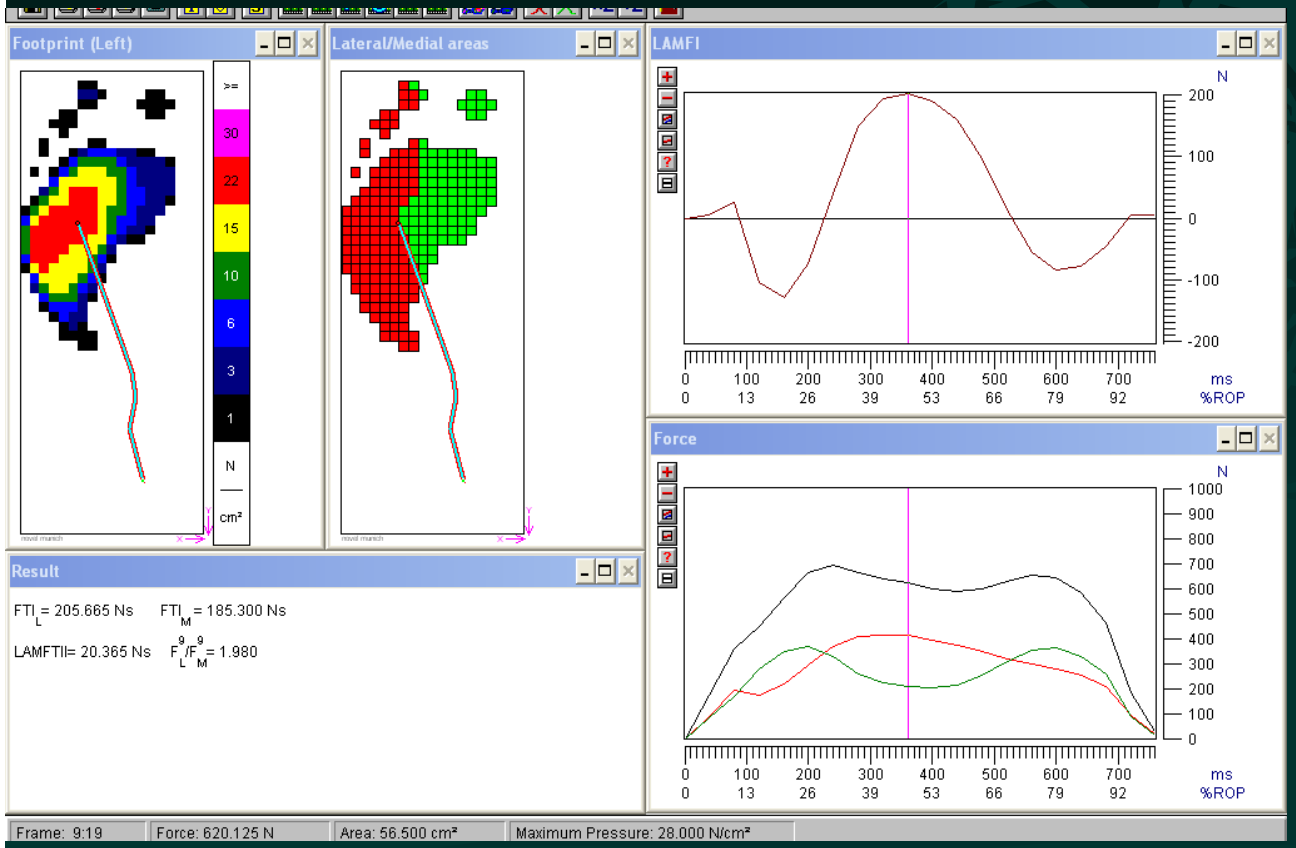
D'après Ducroquet

Valgus le plus souvent

Parallélisme entre la courbe et le COP

Appui plantigrade

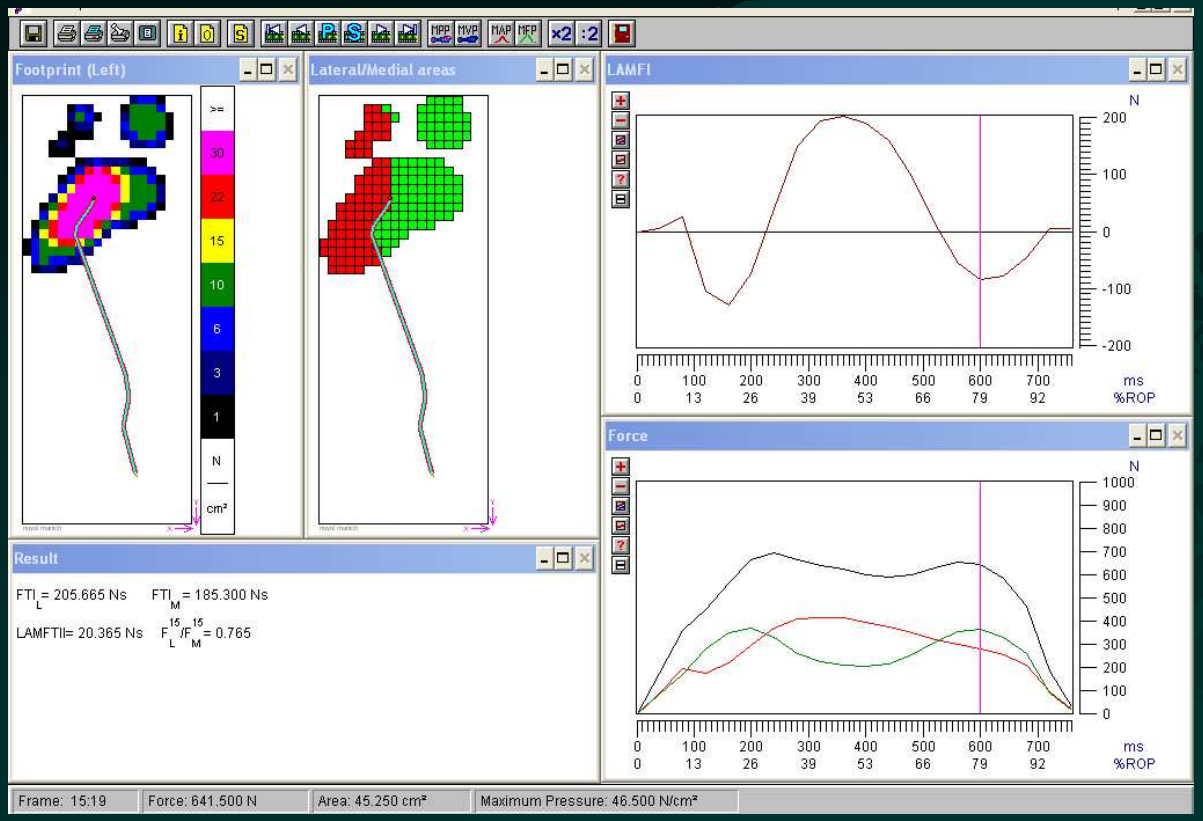


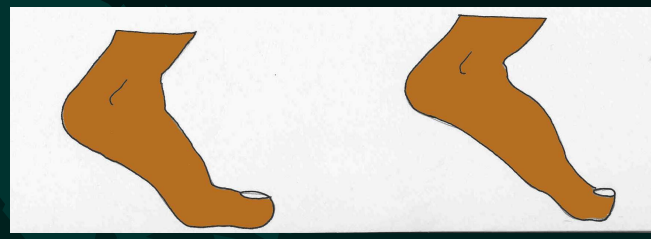


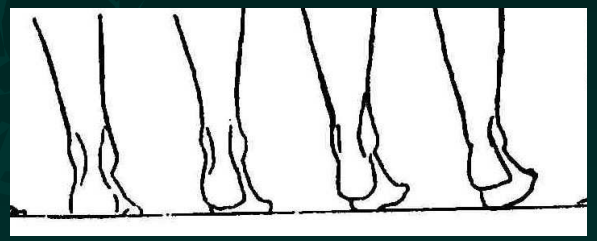
supination

Tibial postérieur

Appui digitigrade







pronation

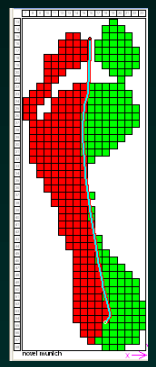
↓

fibulaires

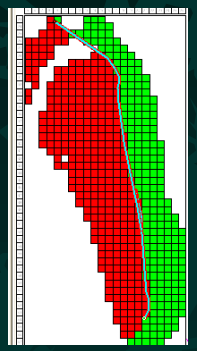
Le bilan baropodométrique dynamique et pied plat

L'index de force latéro-médiale ++

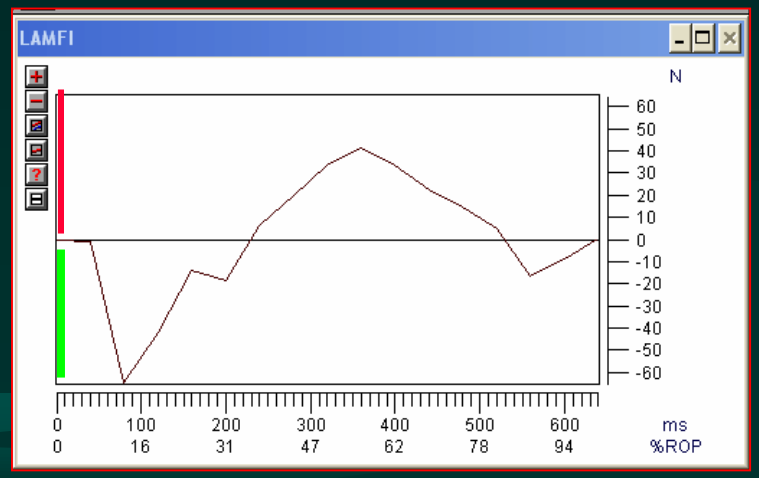
E. Toullec (2005) : Evaluation par baropodométrie dynamique de la force latéro-médiale dans le pied plat valgus sévère avant et après chirurgie, RCO , 91 : 3S129.

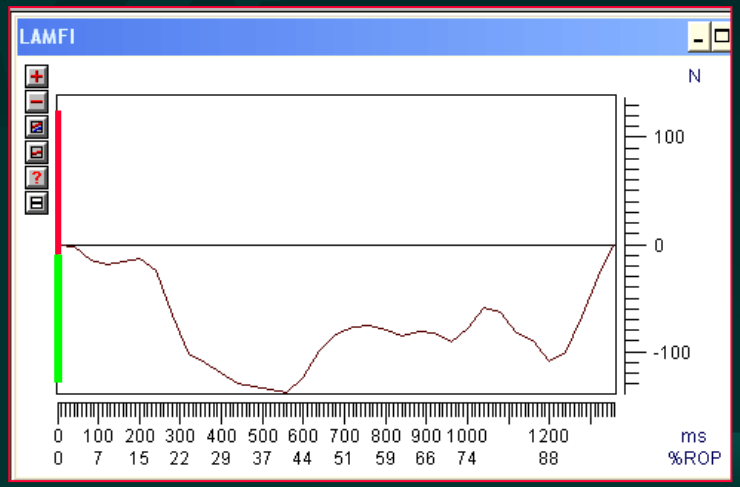


Pied normal

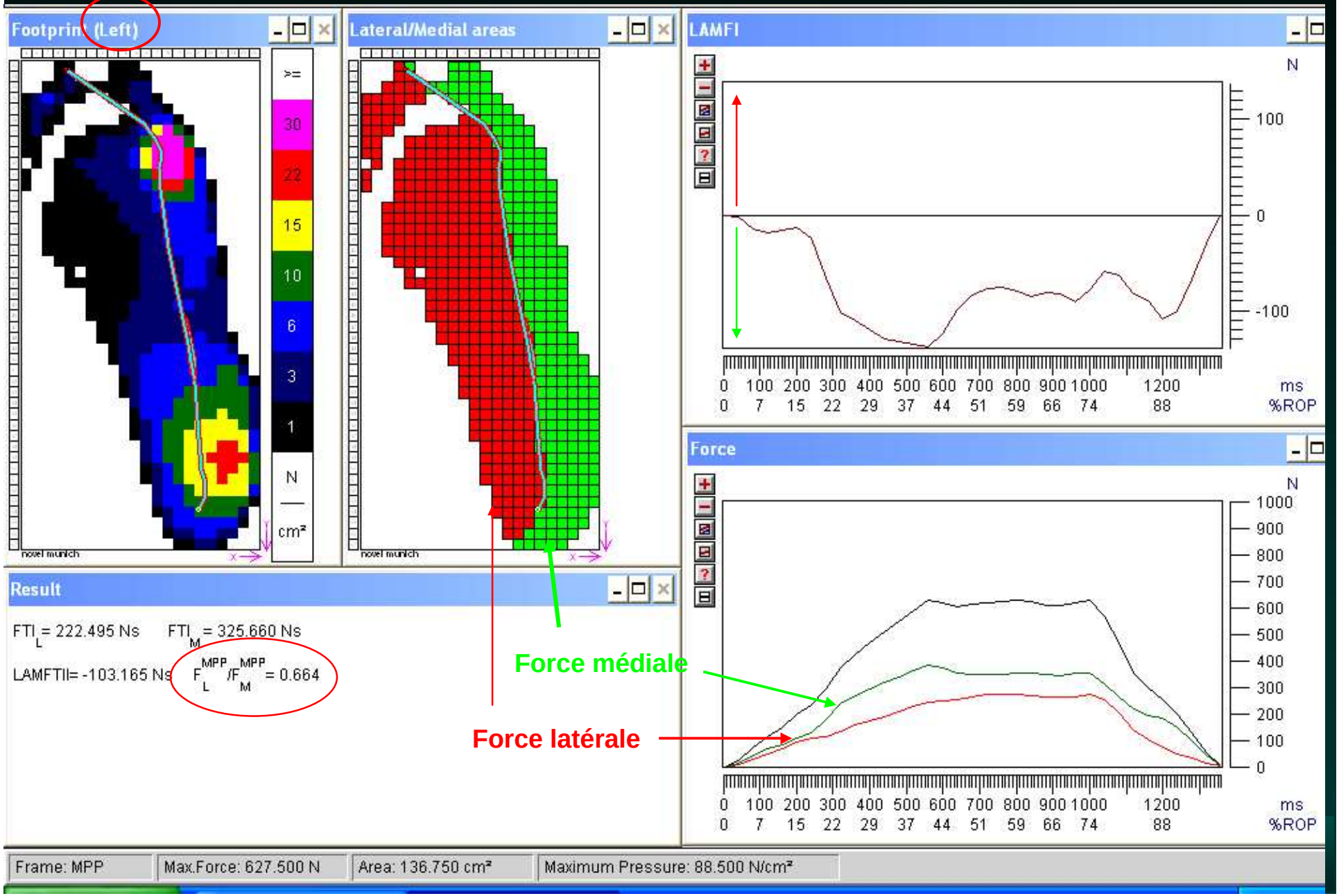


Pied plat valgus

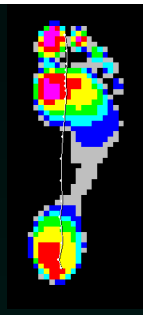




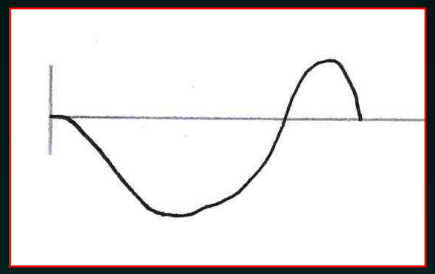
Force médiale durant tout le pas



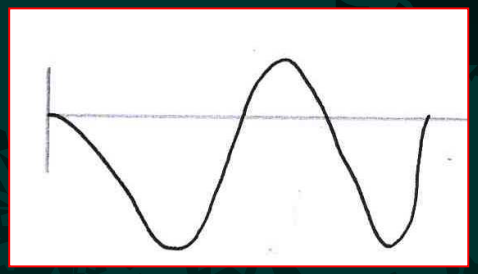
Cependant , cette courbe n'est pas constamment retrouvée



→ Affaissement lors d'une ou de 2 phases de l'appui



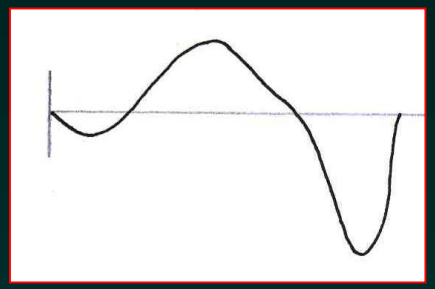
Force médiale
en début du pas
8/28 (29%)
→ valgus AP



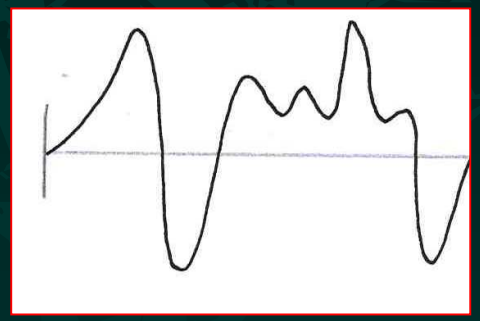
Force médiale en
début et fin du pas

1/28 (4%)

Valgus + hyperpronation

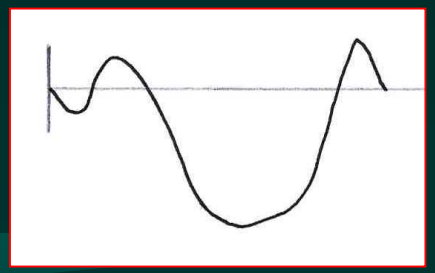


Force médiale
en fin du pas
2/28 (7%)
→ hyperpronation



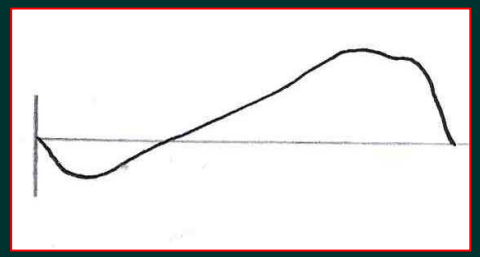
Courbe irrégulière

5/28 (18%)



Force médiale en
milieu du pas

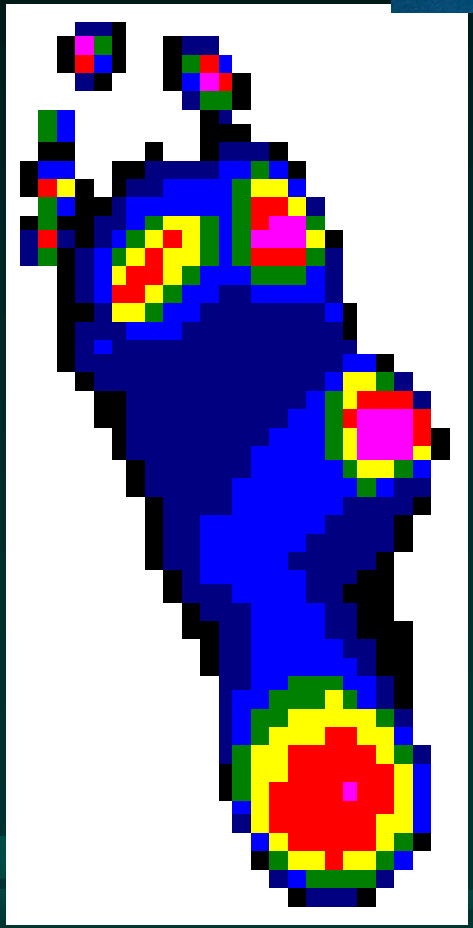
2/28 (7%)

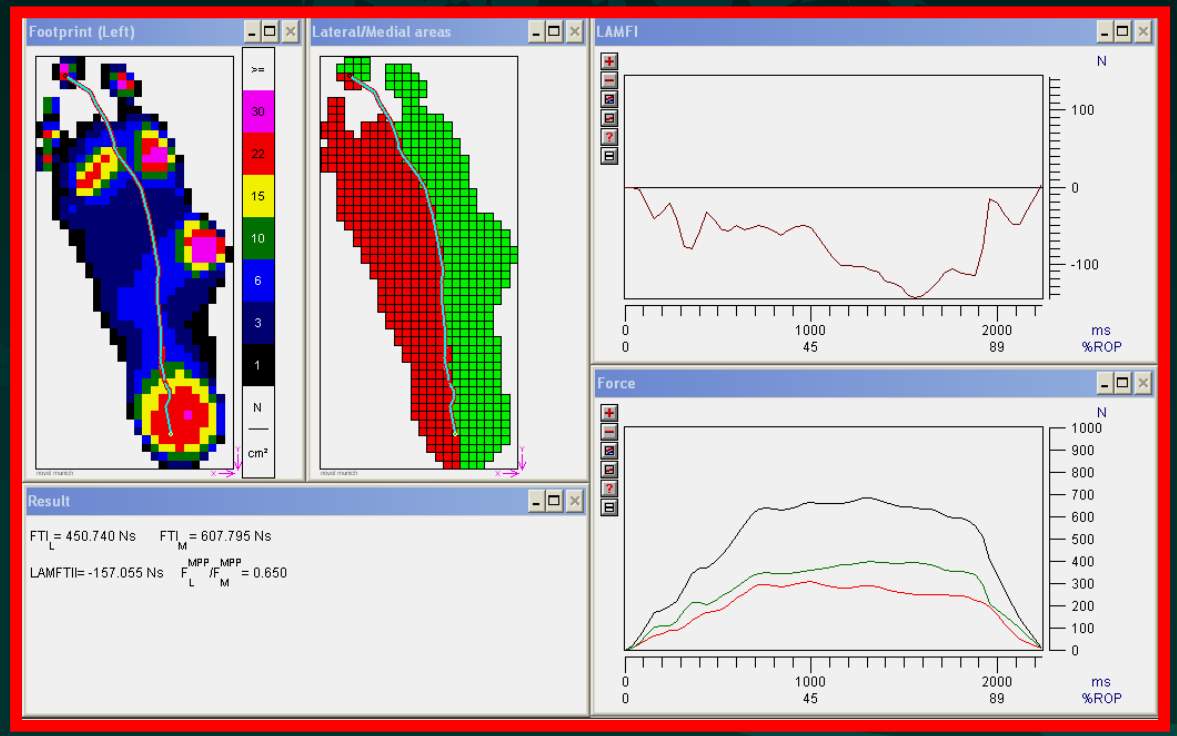


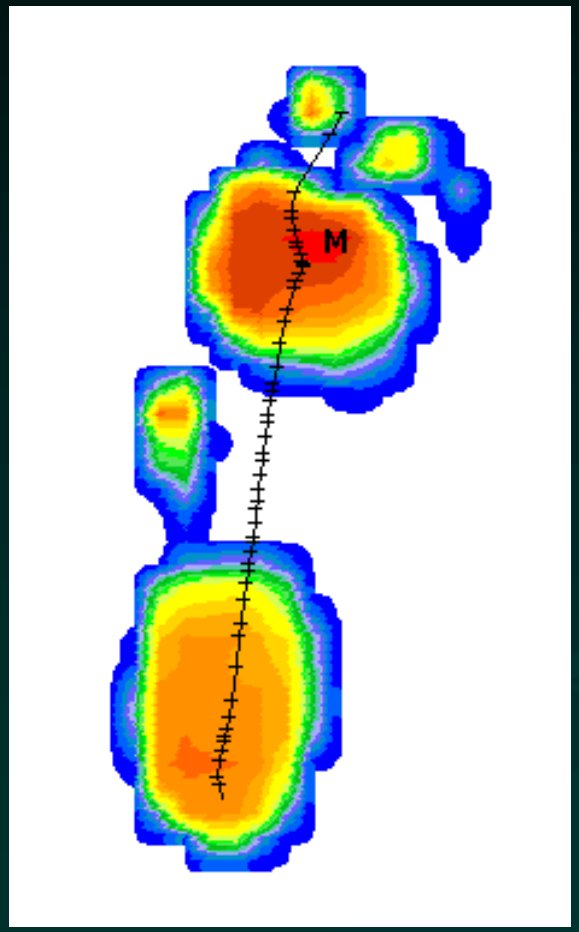
Supination tardive

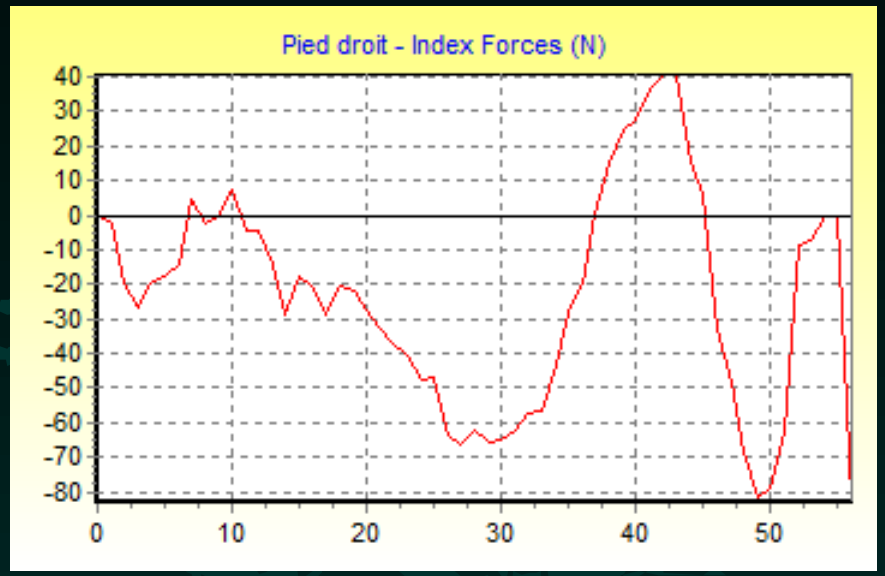
2/28 (7%)

FRANCES ANDRE

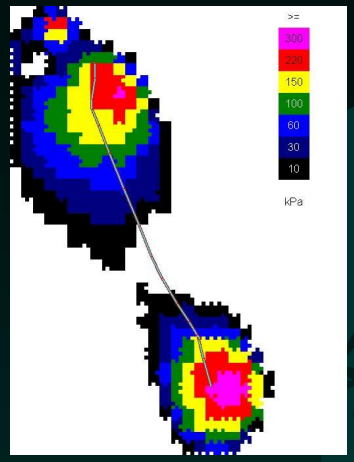


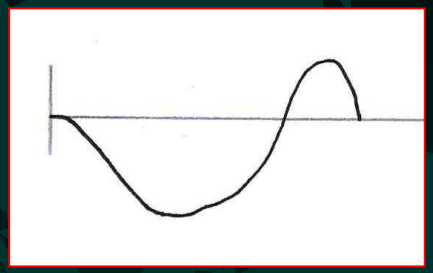

Footprint (Left)
>=
30
22
15
10
6
3
1
N
cm²
Lateral/Medial areas
LAMFI
N
100
0
-100
0
1000
2000
ms
0
45
89
%ROP
Force
N
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
ms
0
45
89
%ROP
Result
FTI L = 450.740 Ns FTI M = 607.795 Ns
LAMFTII= -157.055 Ns F L MPP /F M MPP = 0.650


M


Pied droit - Index Forces (N)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
10
20
30
40
50

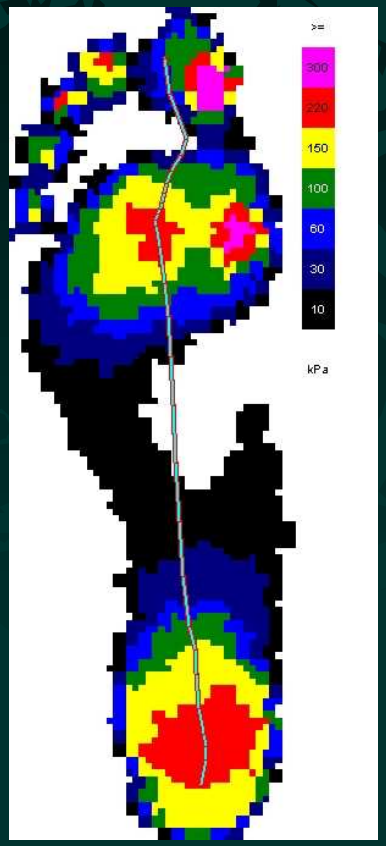
Droit

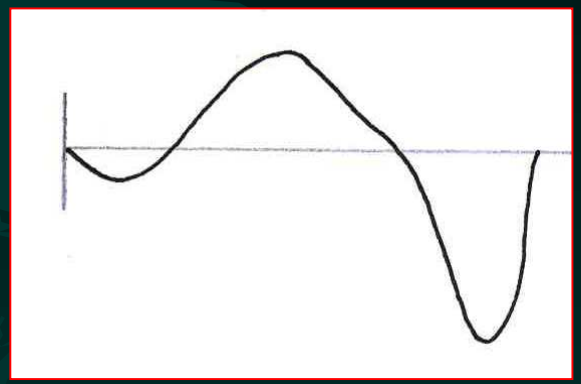




Valgus prédominant

Hyper-pronation





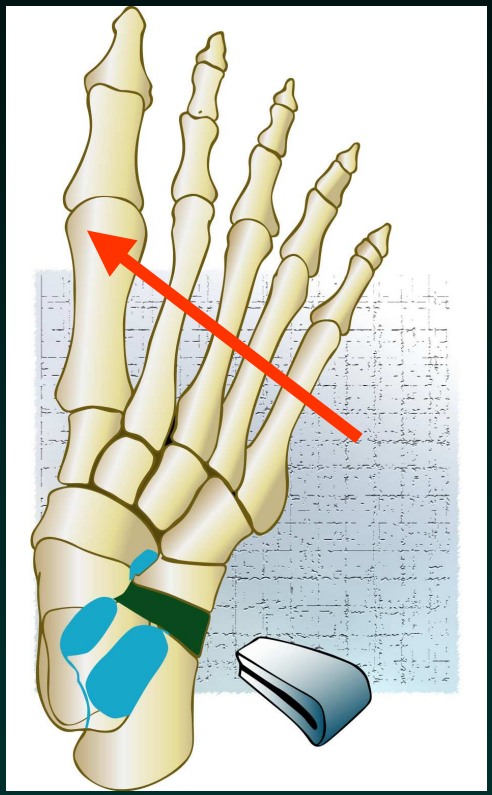
Que se passe t'il après la chirurgie ?

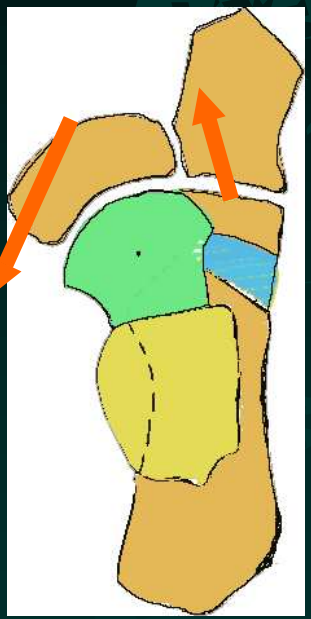
2 types de chirurgie :

-Conservatrice si PPV souple
-Arthrodèse si fixée

Modifications des paramètres après chirurgie

L'ostéotomie d'Evans





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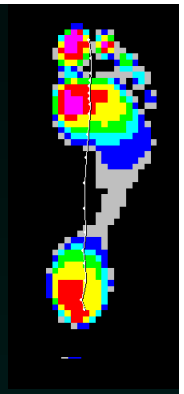
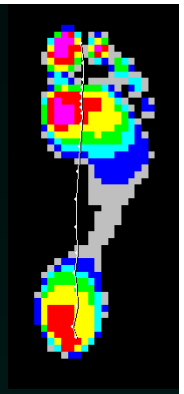


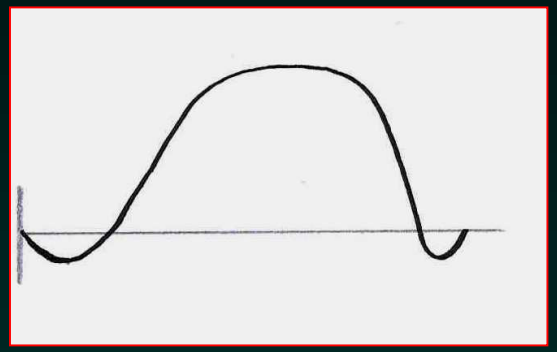
Ostéotomie d'allongement du calcanéum

Modifications des paramètres après chirurgie

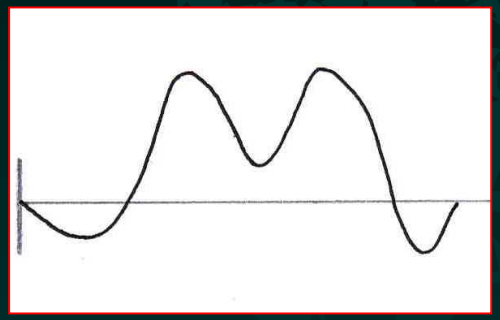


Les courbes LAMFI après chirurgie (suivi > 1 an)

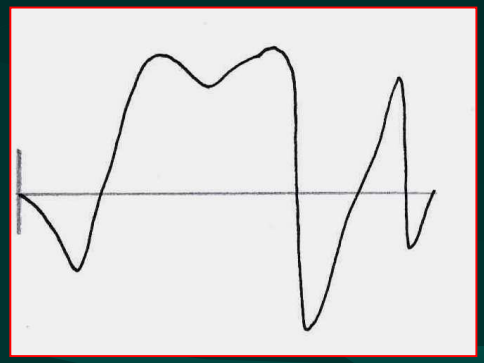
Normale 70 % (19/28)



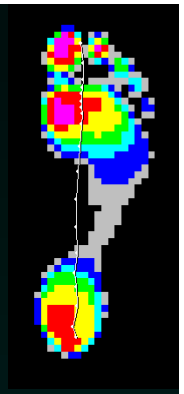
Double dôme 10 % (3/28)



irrégulière 10 % (3/28)



Inchangée 10 % (3/28)

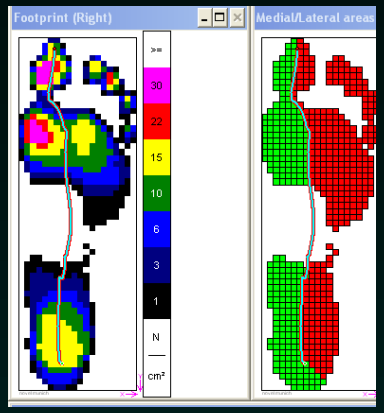


Analyse des résultats

Courbes inchangées (3 cas)

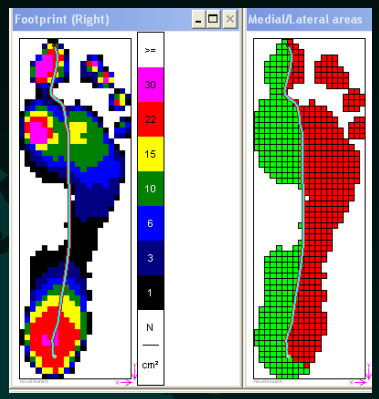
résultats moyens dans les 3 cas :

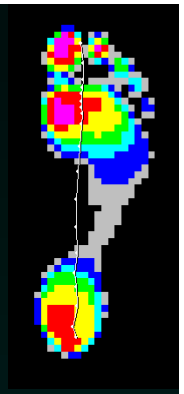
- tassement de greffon avec hypocorrection (1 cas)
- laxité tibio-tarsienne associée sans arthrose (1 cas)
- obèse avec hypermobilité cunéo-métatarsienne non arthrodèsée (1 cas)

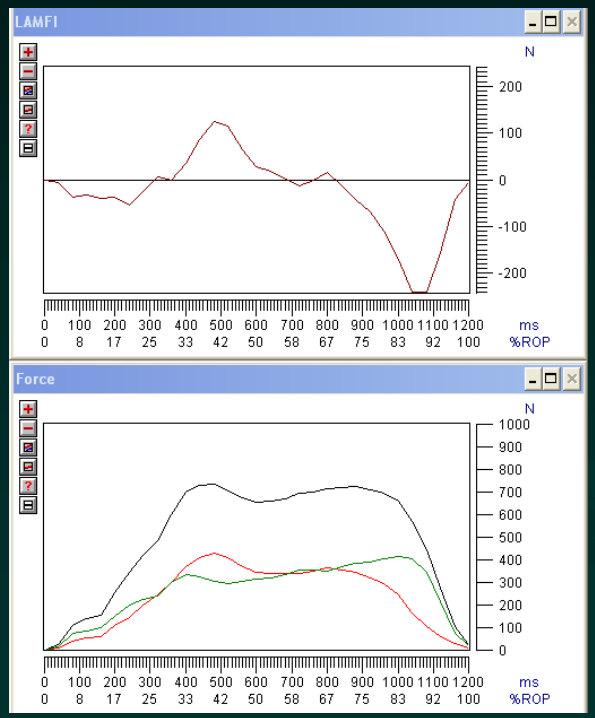


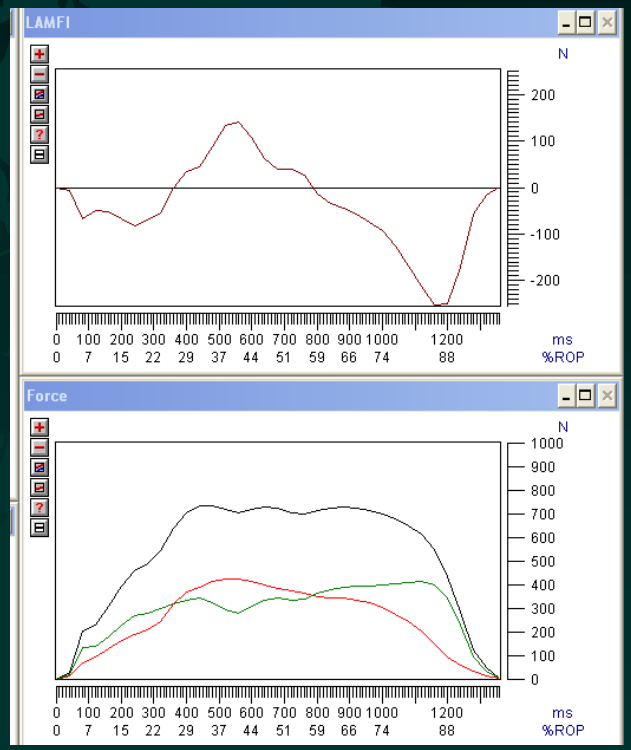
avant

1 an



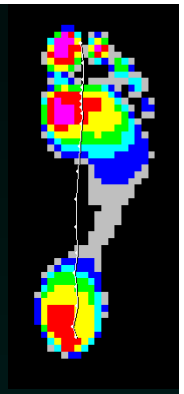






Correction insuffisante par compression du greffon

Modifications des paramètres après chirurgie



Courbes irrégulières (3 cas) :

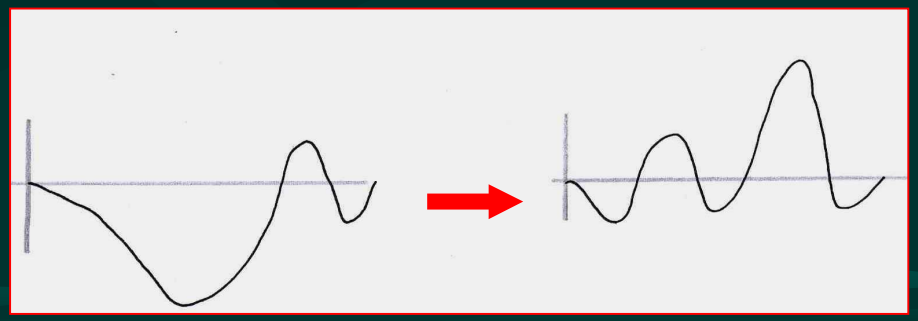
- **résultats moyens dans 2 cas :**

  - pied plat arthrosique TN + NC + CM (1 cas)
    défaut d'appui de l'hallux

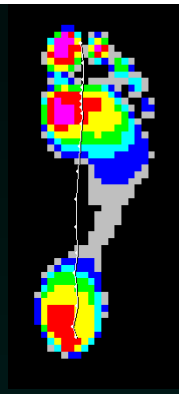
  - laxité tibio-tarsienne associée avec arthrose TN (1 cas)

- **1 bon résultat :**

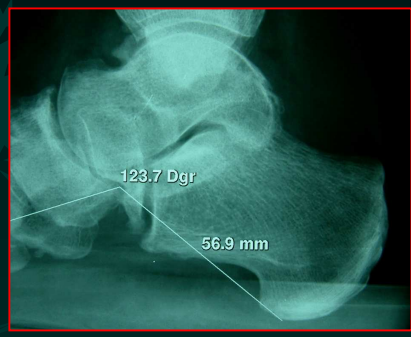
  - séquelle de pied bot varus équin opposé :
    → courbe liée au membre inférieur opposé



Modifications des paramètres après chirurgie



Courbes normales mais résultat non satisfaisant (3 cas) :



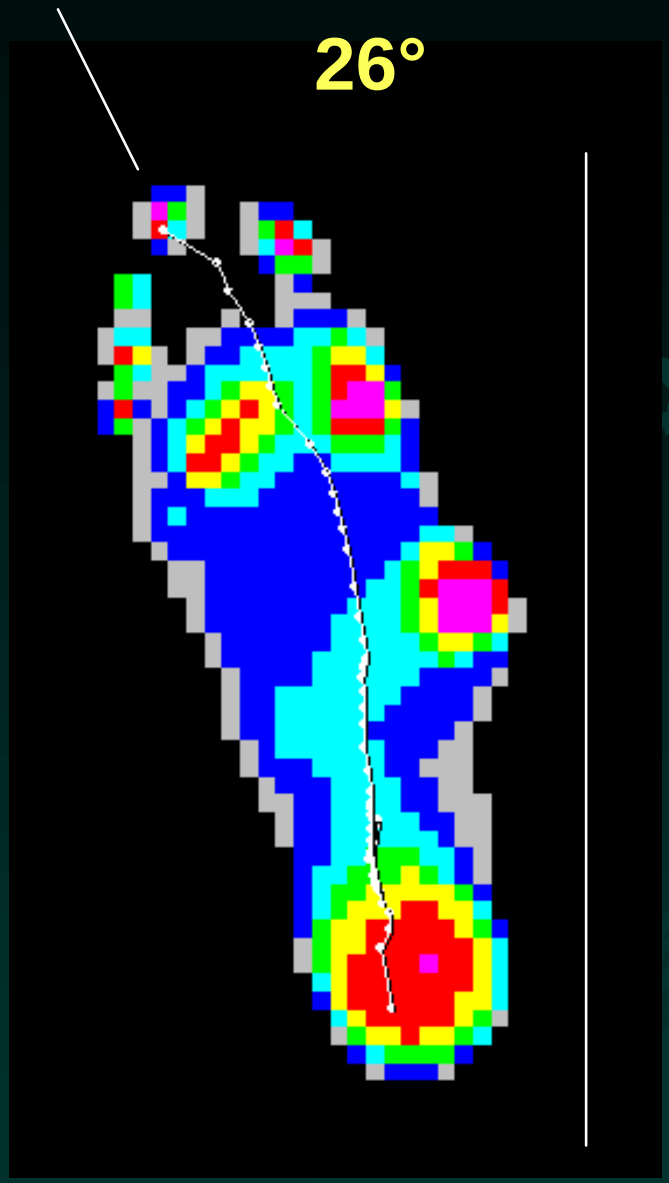
- pseudarthrose de l'ostéotomie du calcanéum

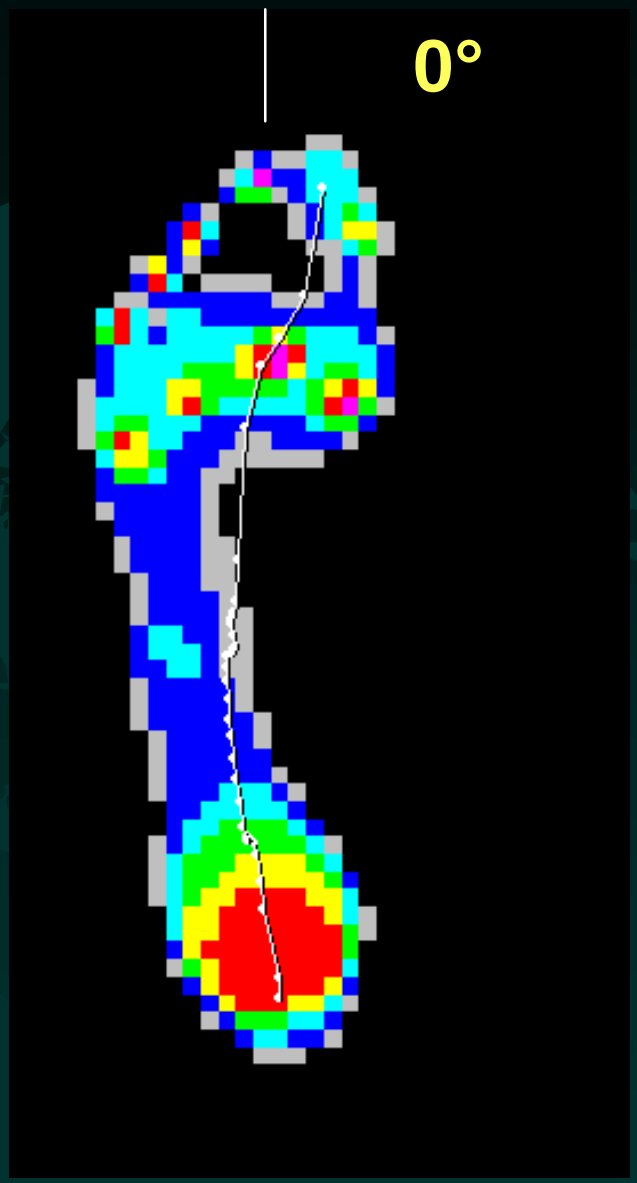
- tassement du greffon (double dôme)
  avec défaut d'appui des orteils

- arthrose MP1 séquelle d'une chirurgie ancienne d'un HV
  traitée par arthrodèse MP1
  + arthrose CC et ST secondaire à 3 ans
  → mauvais résultat

Homme 71 ans – dysfonction TP

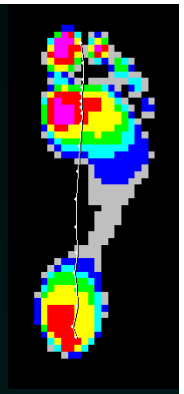
Evans + arthrodèse CM1

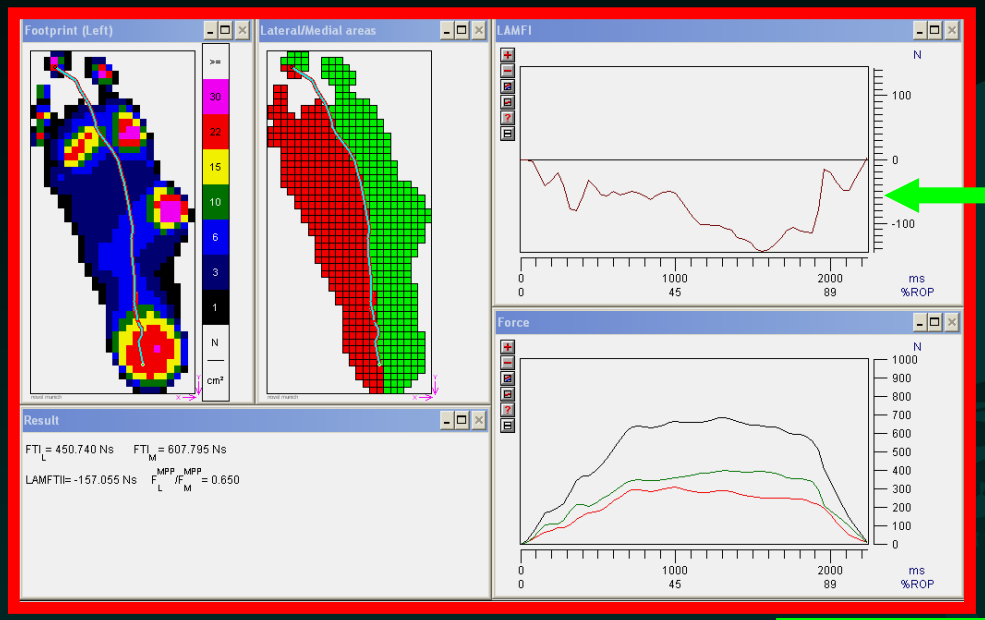


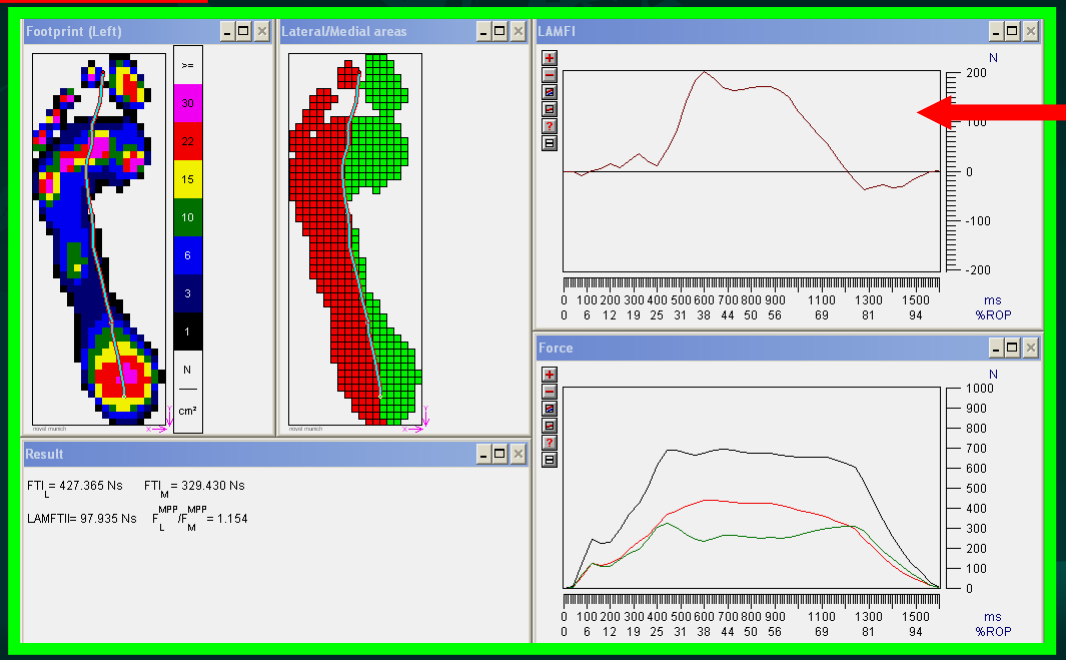


1 an

Modifications des paramètres après chirurgie



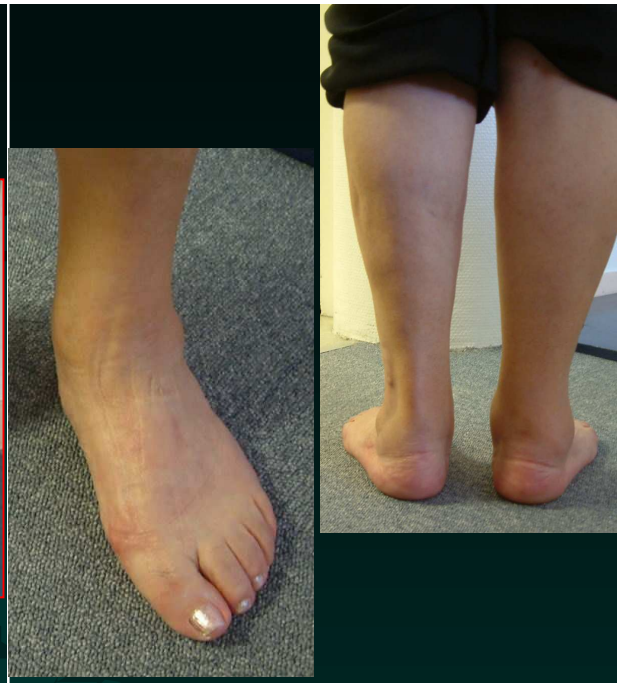




1 an

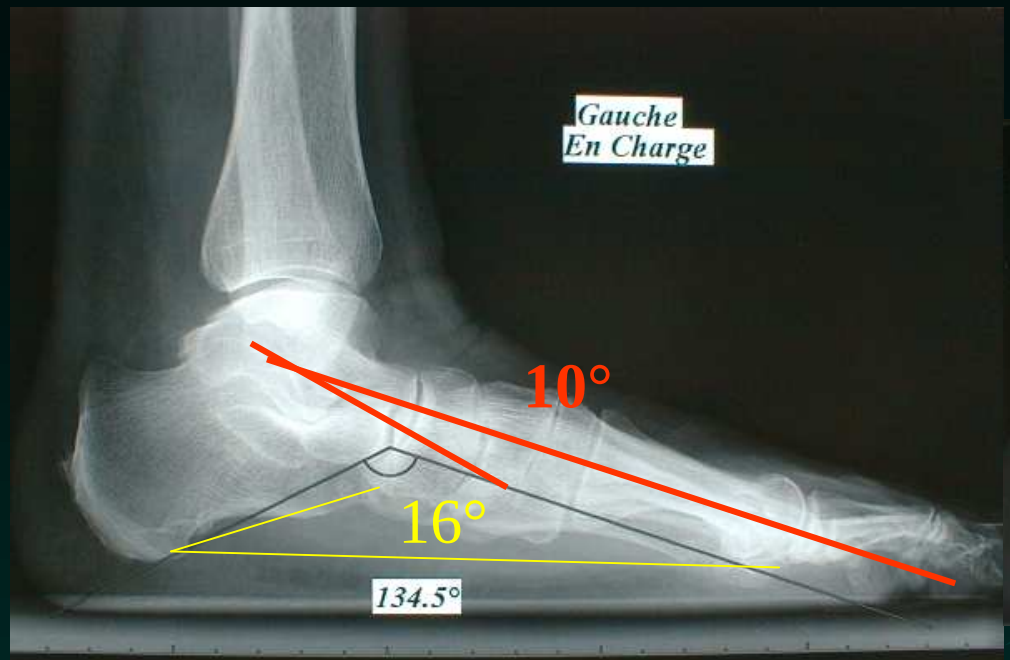
femme 65 ans –
rupture du tibial postérieur :
Evans & scarf
sans réparation du tibial post

2 ans après



6 ans après

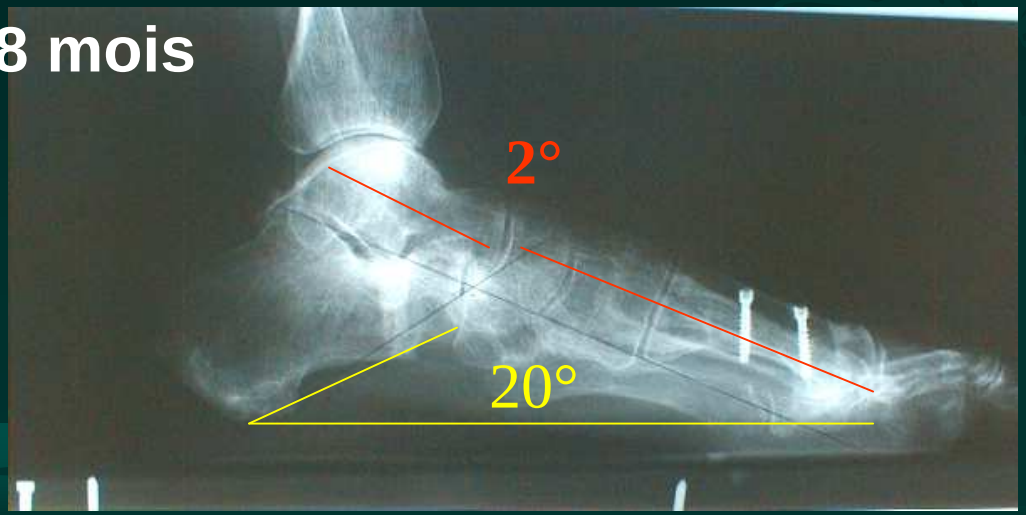
Pointe des pieds à 6 ans



avant

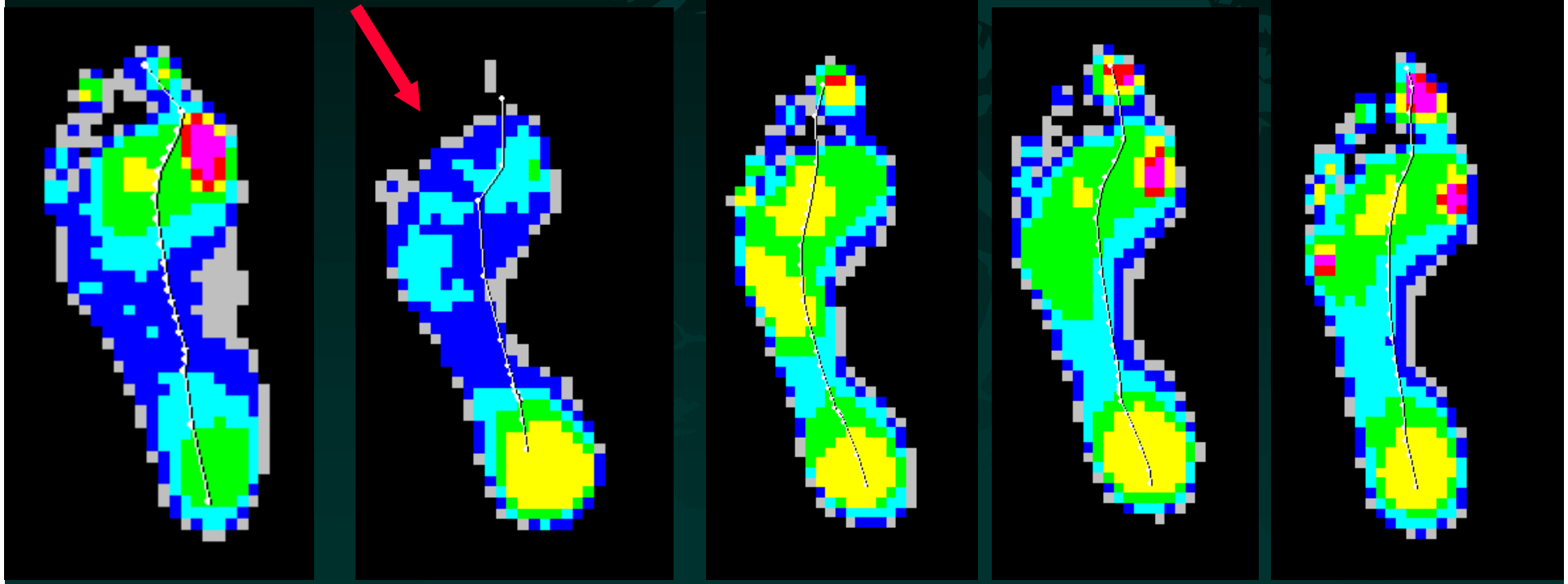
2 ans

8 mois

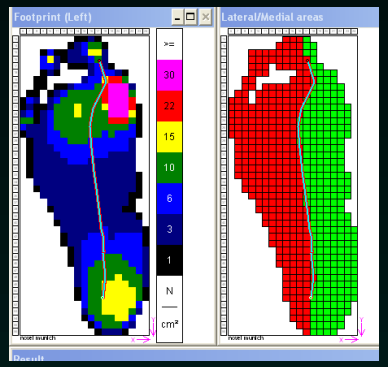


6 ans

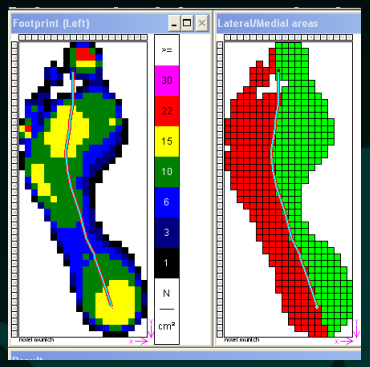
144.5°
Fin Charge



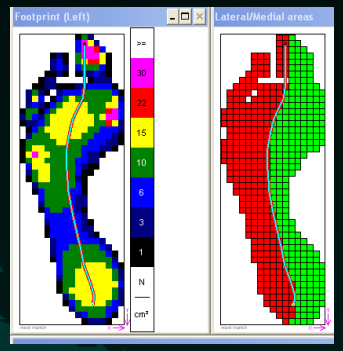
avant | 8 mois | 2 ans | 4 ans | 6 ans



FL/FM = 0,742



FL/FM = 1,045



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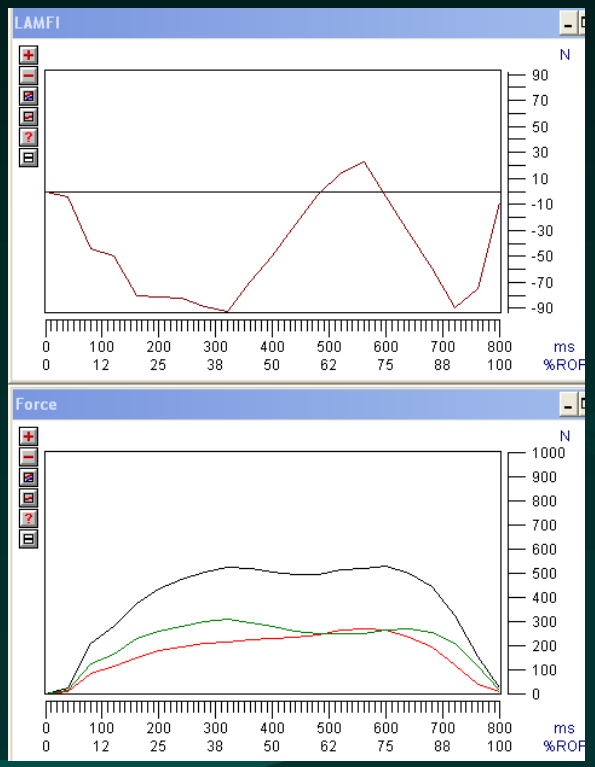
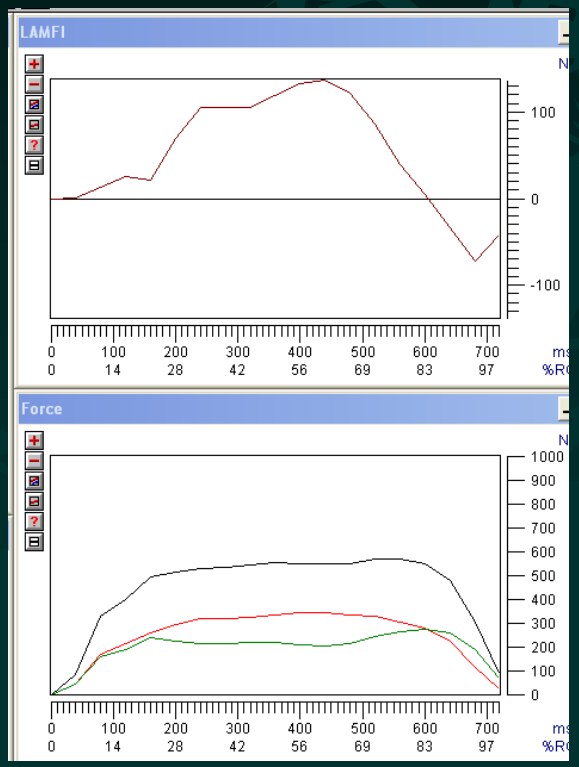
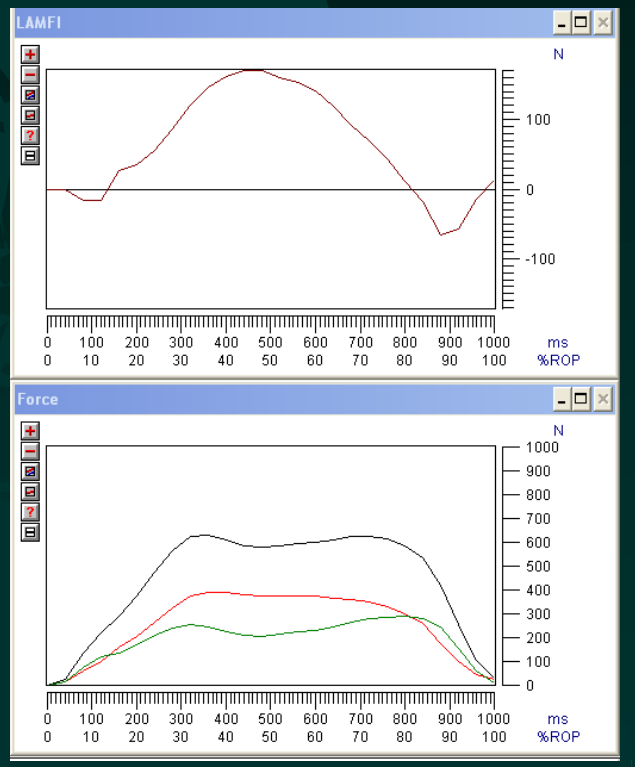


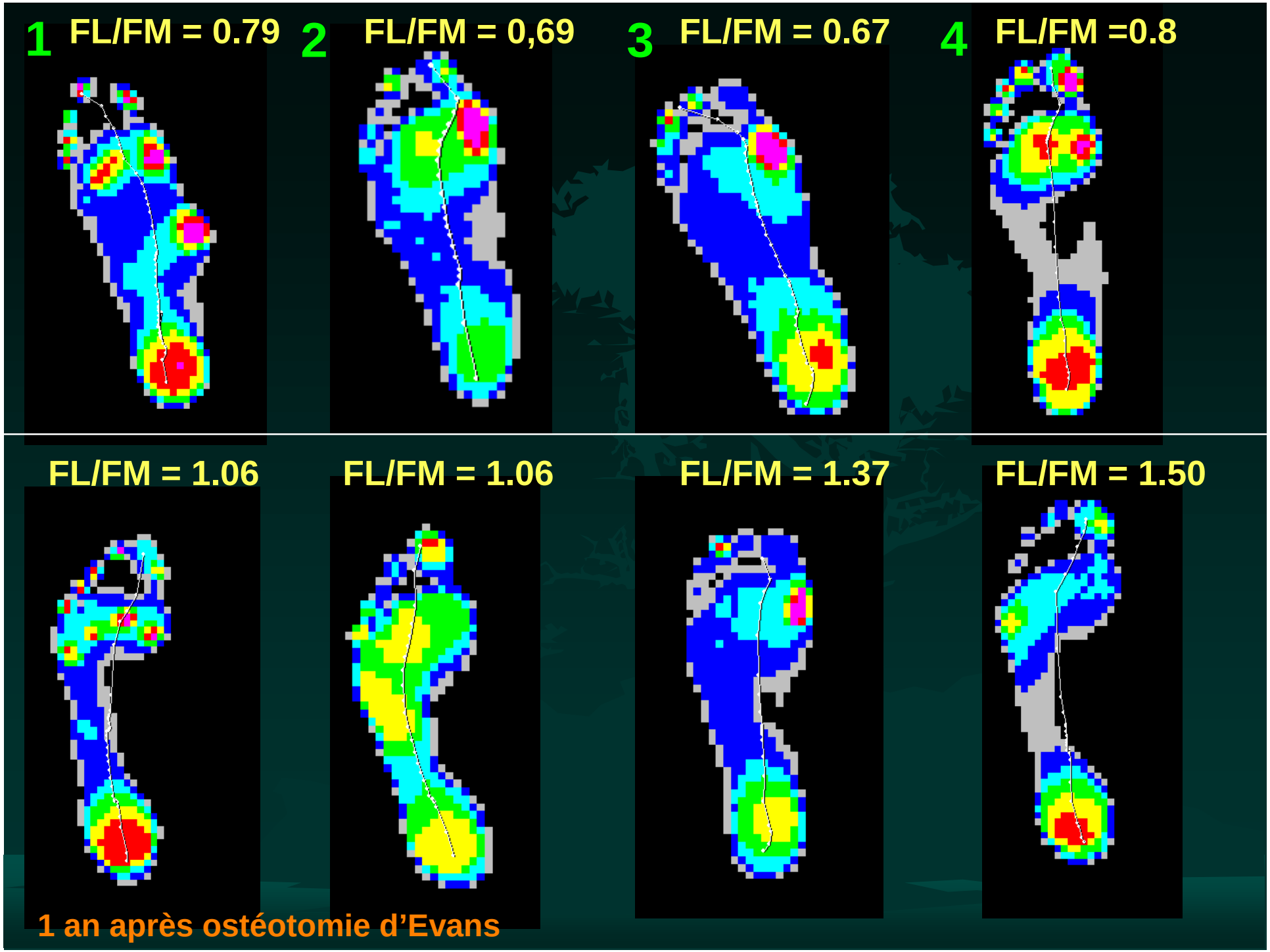
Pré-opératoire



2 ans



6 ans


1
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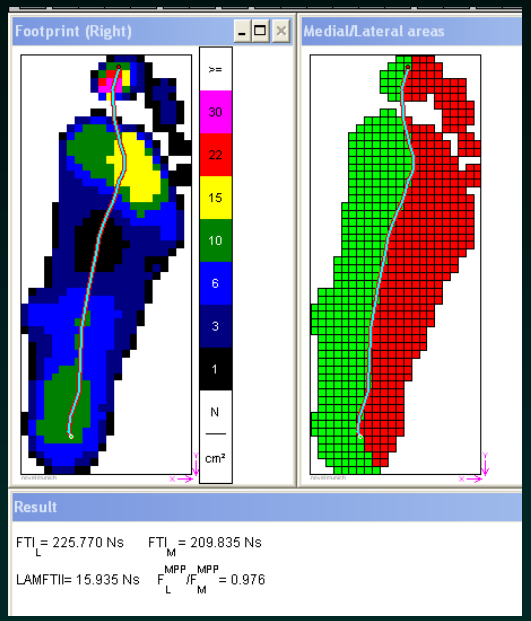
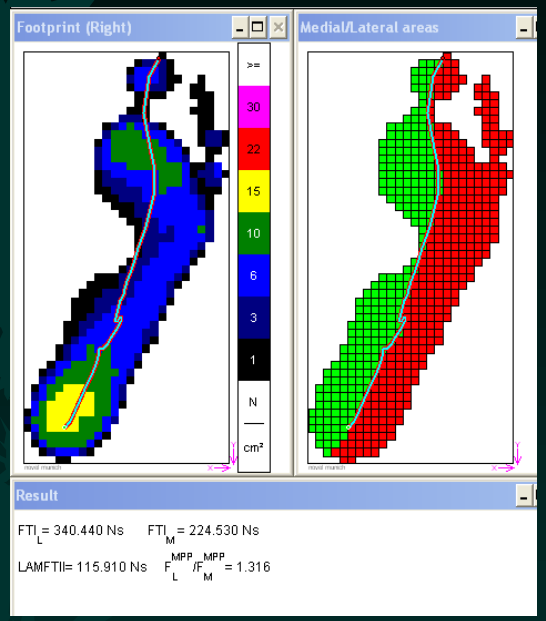
2
FL/FM = 0,69
3
FL/FM = 0.67
4
FL/FM =0.8
FL/FM = 1.06
FL/FM = 1.06
FL/FM = 1.37
FL/FM = 1.50
1 an après ostéotomie d'Evans

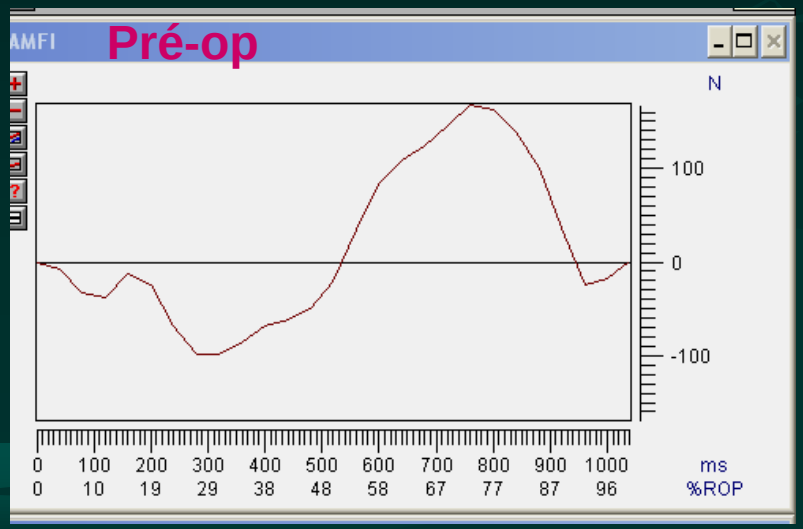
Que se passe t'il après la chirurgie ?

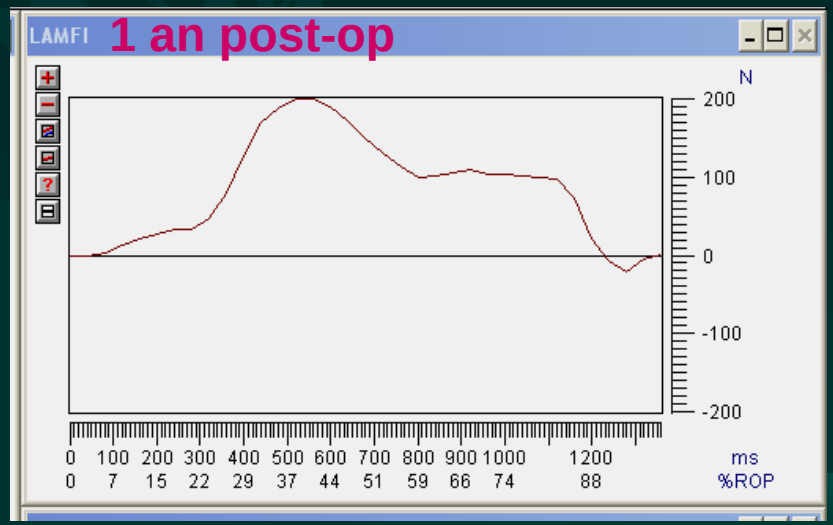
Comparaisons de techniques

Courbe après ostéotomie de translation médiale + transfert FCO

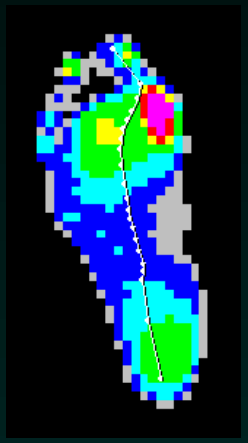


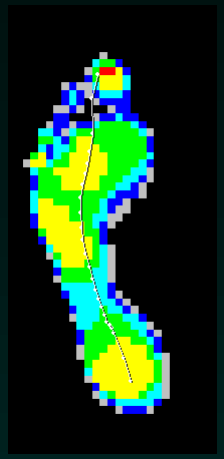


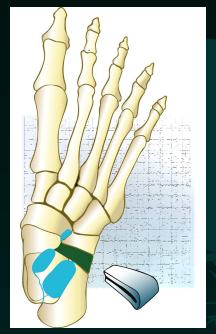




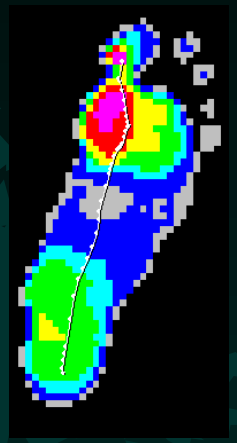
Comparaison des techniques

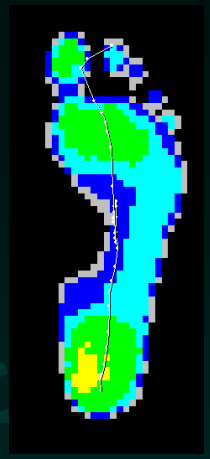






Evans + Scarf M1





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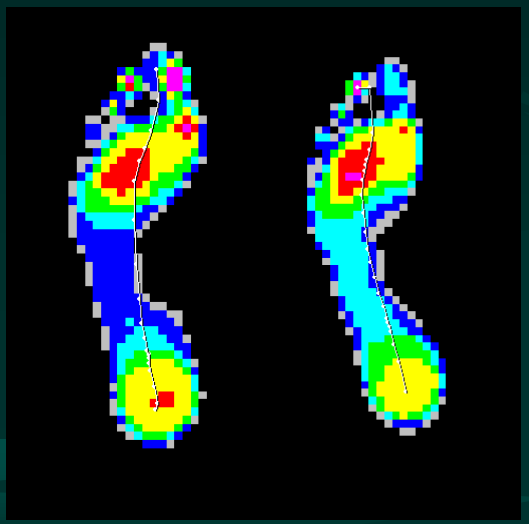
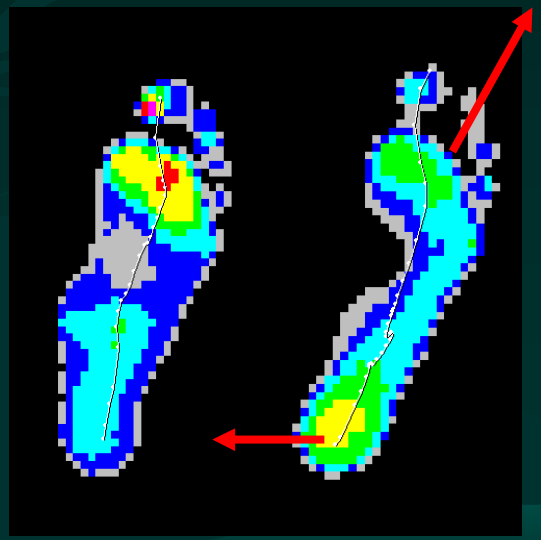
translation médiale + transfert FCO





CONCLUSION

La baropodométrie dynamique trouve un intérêt dans le traitement des pieds plats valgus pour:

- **l'analyse pré-thérapeutique (classification)**
- **la surveillance post-thérapeutique**
  - **à court terme / orthèse**
    / kinésithérapie
  - **à long terme : temps d'acquisition du résultat**

Place de l'analyse baropodométrique avant et après chirurgie du pied plat