Entretiens de Bichat – Paris – 1 octobre 2010

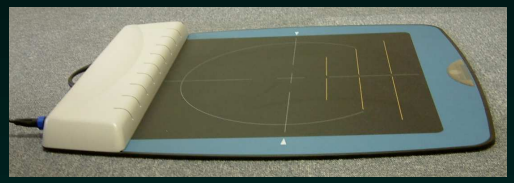
Place de l'analyse baropodométrique dans la chirurgie du pied plat valgus

Dr Eric TOULLEC (Bordeaux)

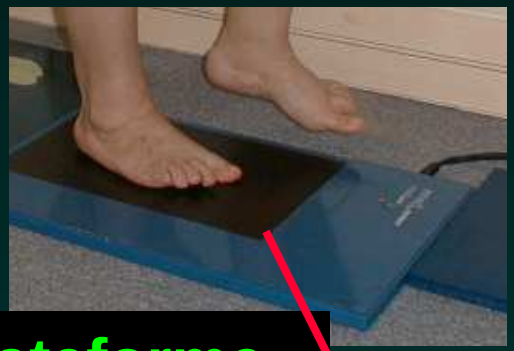
www.chirurgie-cheville-pied.com

Pas de conflit d'intérêt

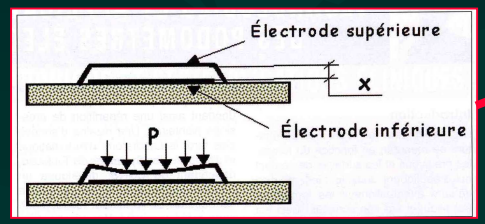
La baropodométrie est l'analyse des forces (pressions) du pied au sol .



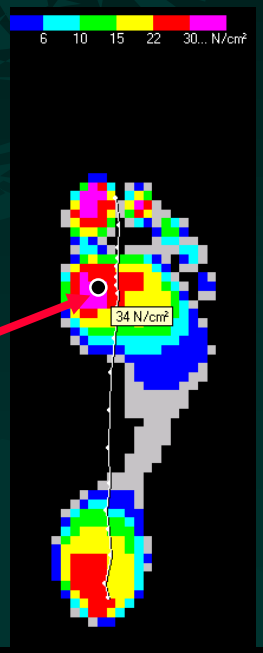
<u>Principe</u> du capteur de force
= convertir la pression en tension électrique



Plateforme ou semelles embarquées



capteurs



Mesure sur ordinateur

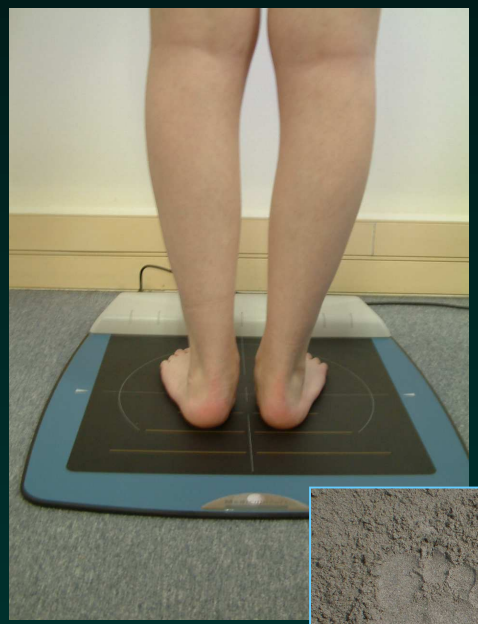
La baropodométrie est un examen
- de la posture
- de la marche

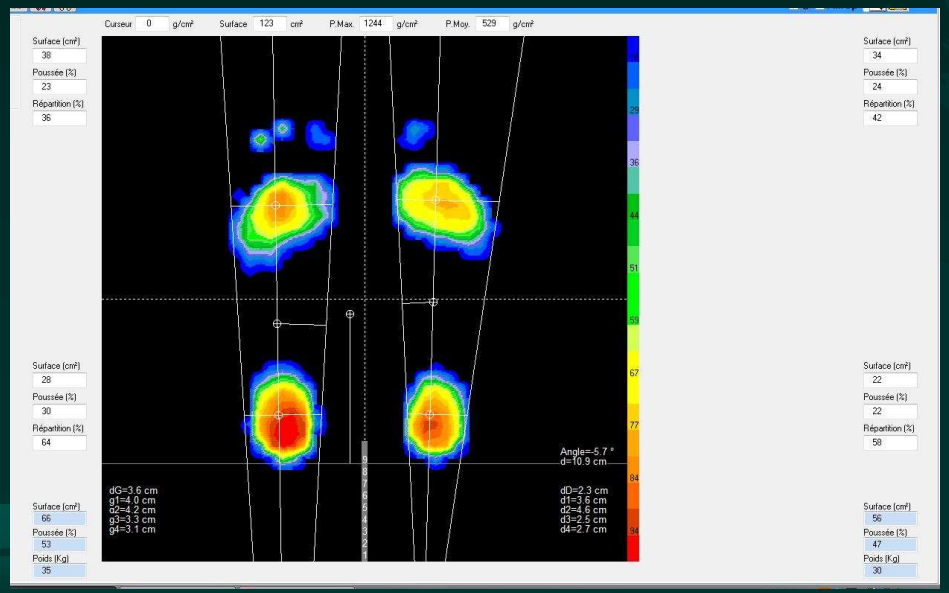
qui concerne l'ensemble
des membres inférieurs et du corps
et pas seulement le pied et la cheville

Tj interpréter le résultat / clinique+++

Baropodométrie statique ou dynamique ?

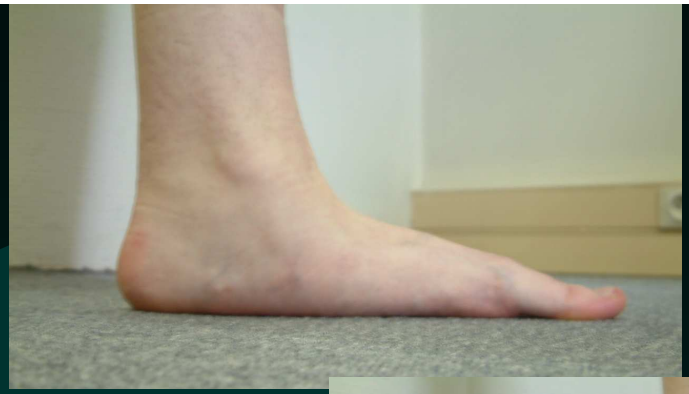
1- l’examen statique = la posture .

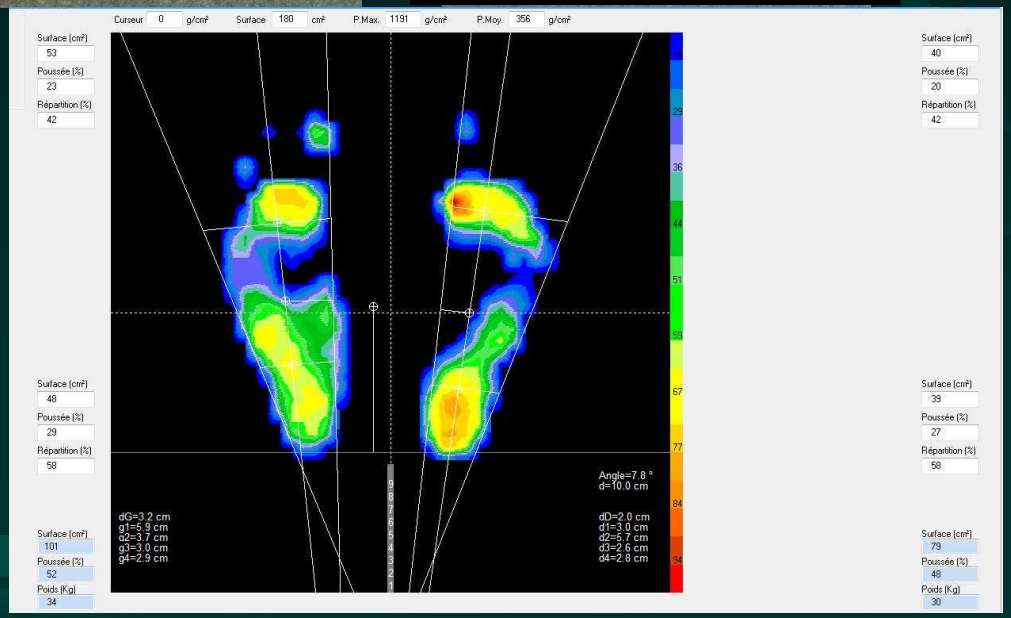



Curseur 0 g/cm²
Surface 123 cm²
P.Max. 1244 g/cm²
P.Moy. 529 g/cm²
Surface (cm²) 38
Poussée (%) 23
Répartition (%) 36
Surface (cm²) 34
Poussée (%) 24
Répartition (%) 42
Surface (cm²) 28
Poussée (%) 30
Répartition (%) 64
Surface (cm²) 22
Poussée (%) 22
Répartition (%) 58
Surface (cm²) 66
Poussée (%) 53
Poids (Kg) 35
Surface (cm²) 56
Poussée (%) 47
Poids (Kg) 30
dG=3.6 cm
g1=4.0 cm
d2=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
Angle=-5.7 °
d=10.9 cm

Pied valgus

Too many toes sign

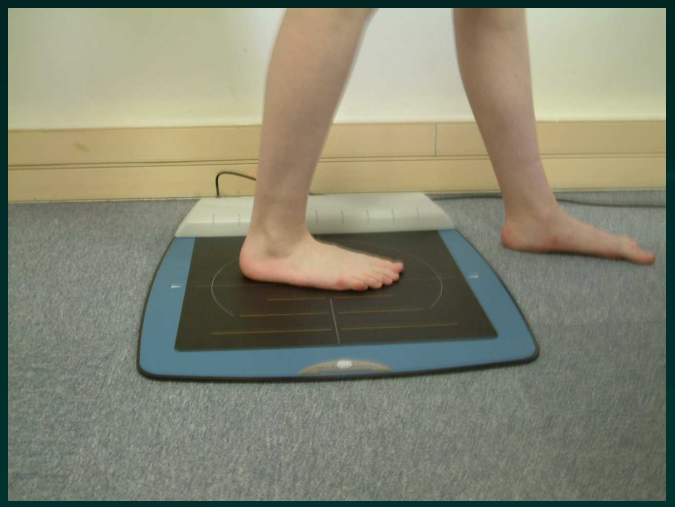




Pied abductus

Baropodométrie statique ou dynamique ?

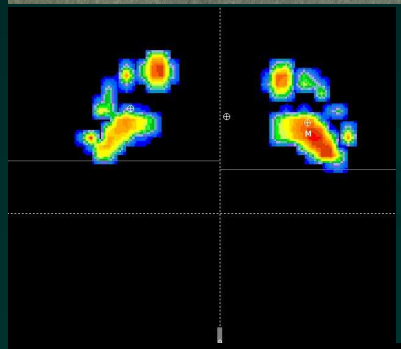
2 – la baropodométrie dynamique : la fonction & la marche .

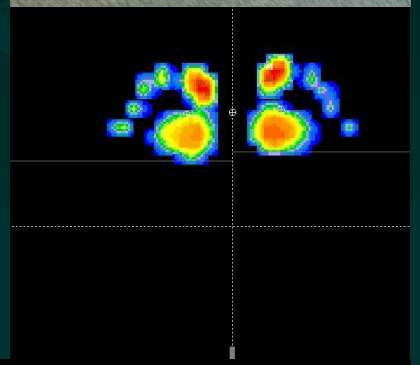


2 – la baropodométrie dynamique :

Baropodométrie séquentielle (JY Cornut)

Mouvements spécifiques sur la plateforme





2 exemples de pointe des pieds bipodal

Pied plat valgus

= défaut de verrouillage du pied à la marche

Dysfonction tibial postérieur

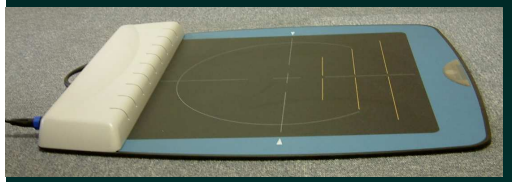
normal

Baropodométrie dynamique

= analyse du déficit fonctionnel

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

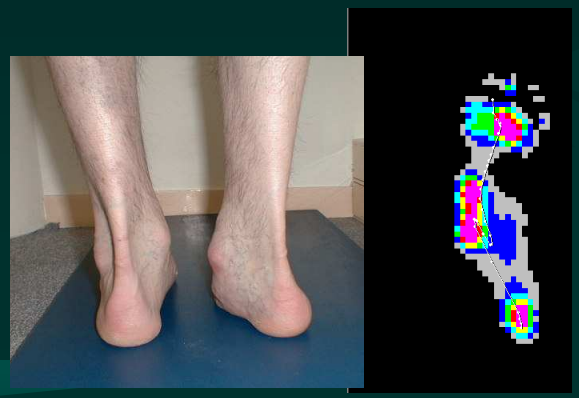
Nécessité de plusieurs passages : 3 à 5 / pied = reproductibilité
et toujours les 2 pieds

Mêmes conditions d'examen en pré et post-op

Problèmes rencontrés dans le pied plat

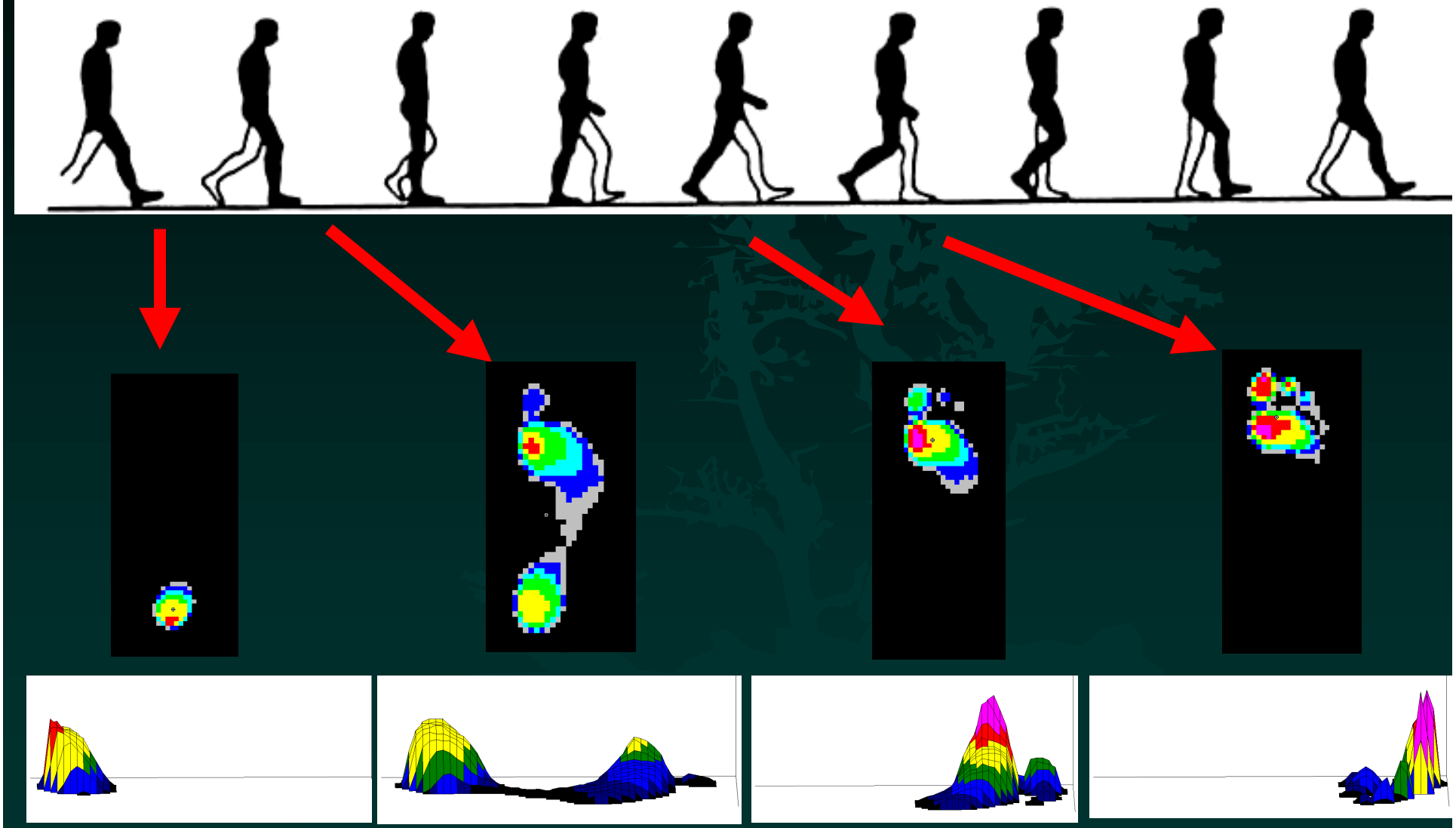
* Rotation externe du pied incompatible avec l'étroitesse de la plateforme :
le patient est tenté de réaxer son pied !

* Difficultés de marche : analyse du 1er pas



*Mauvaise reconnaissance du côté
Ici , côté droit

Baropodométrie dynamique : phase d'appui



Attaque talon
(0 à 15%)

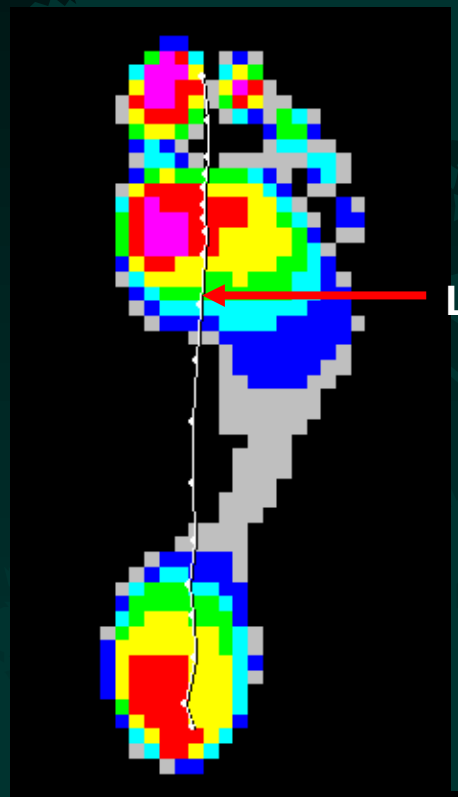
Phase plantigrade
(15 à 40%)

Lever talon
(40 à 50%)

propulsion
(50 à 60%)

Le résultat normal

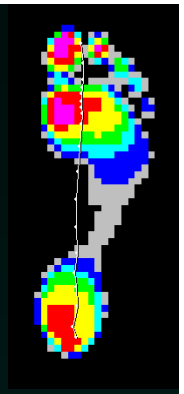
- 0 à 1 N/cm²
- 1 à 3 N/cm²
- 3 à 6 N/cm²
- 6 à 10 N/cm²
- 10 à 15 N/cm²
- 15 à 22 N/cm²
- 22 à 30 N/cm²
- > 30N/cm²



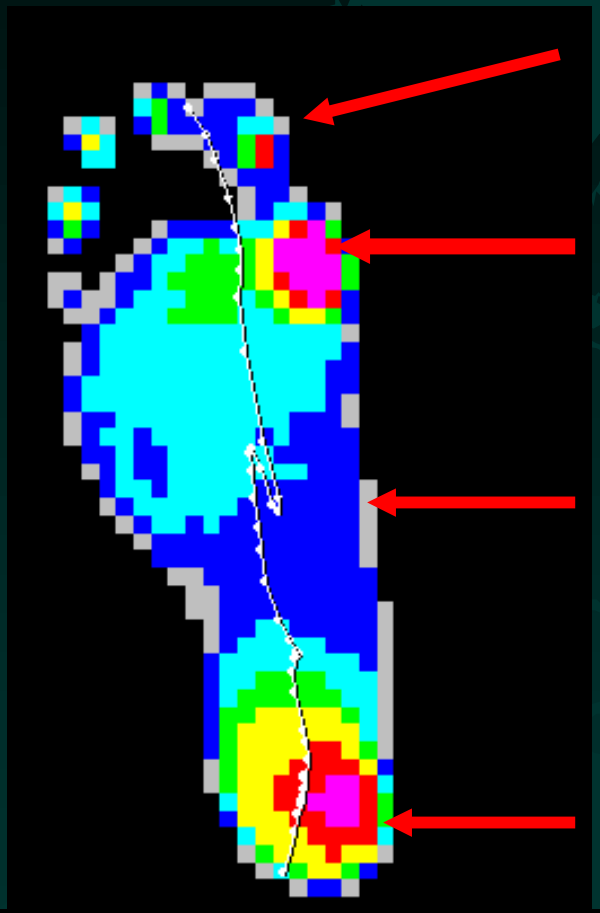
Empreinte normale

= synthèse d'images dynamiques

Facteurs baropodométrique du pied plat



Pas de critères constants



Hallux valgus (40%)

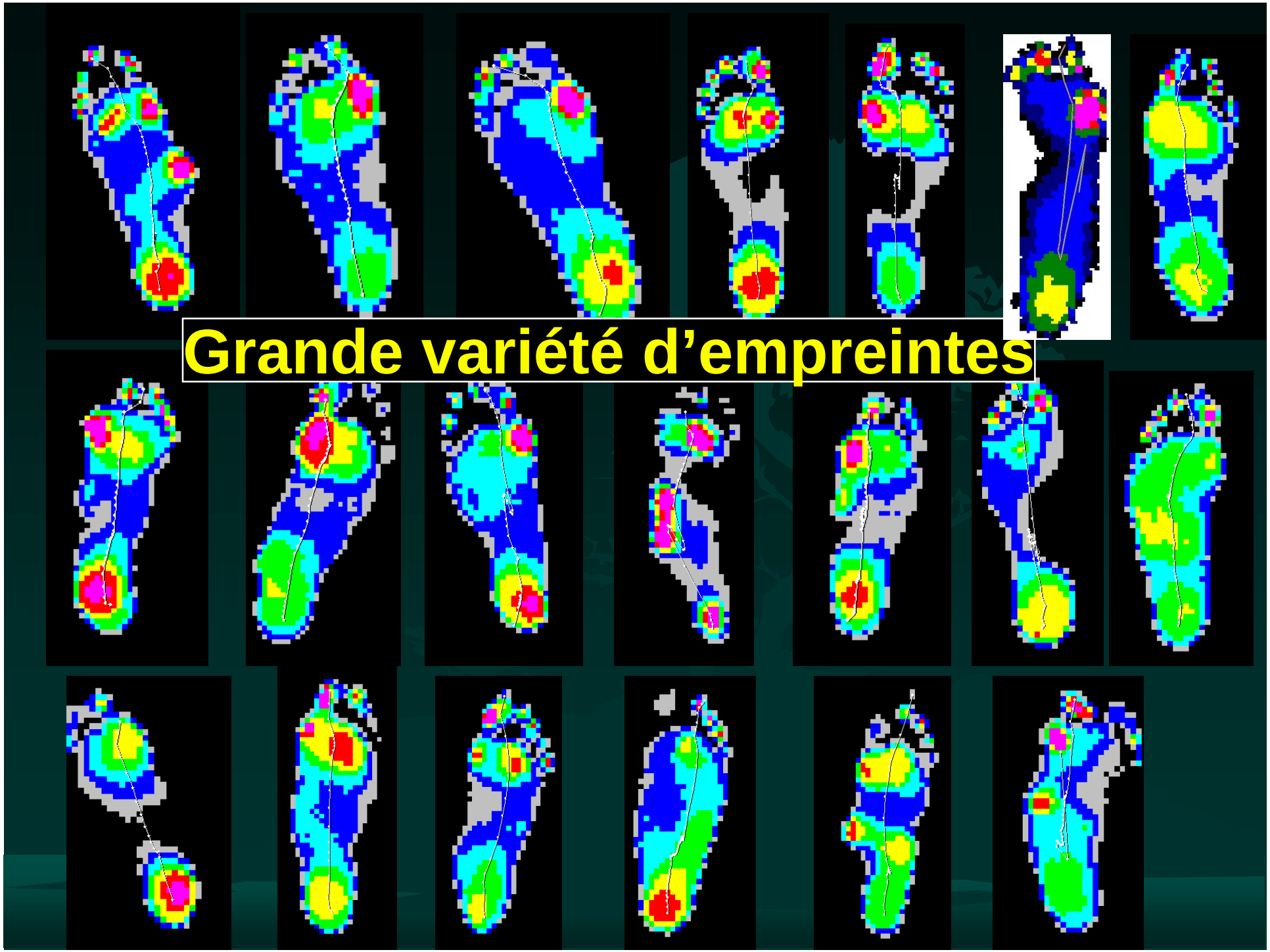
Hyper-appui sous tête M1 +++ (70%)

Médio-pied large (60%)

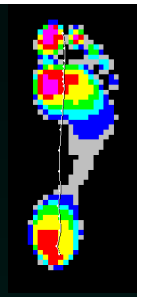
Valgus arrière-pied (70%)

abduction Avant-pied (60%)

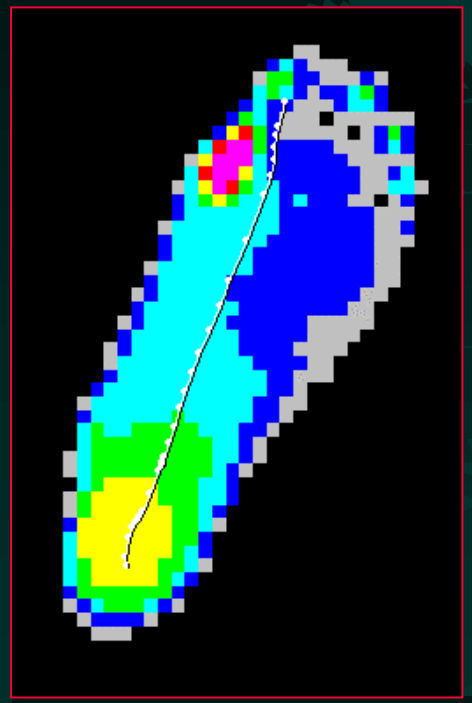
E.Toullec , LS Barouk : Intérêt de la baropodométrie dynamique dans l'analyse de la chirurgie du pied plat valgus de l'adulte. Med Chir Pied. 2004 ; 20 :17-22.


Grande variété d’empreintes

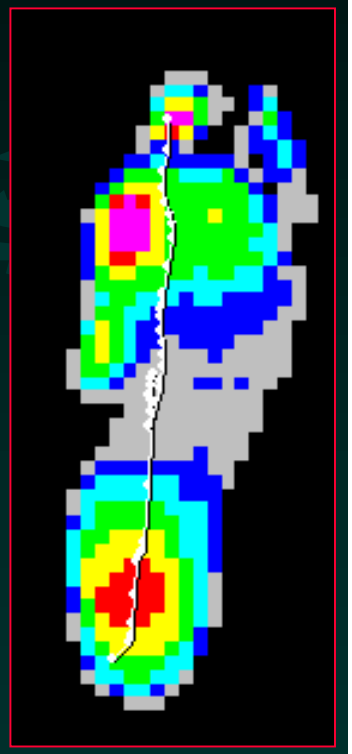
La baropodométrie dynamique dans pied plat valgus



Classification de Toullec

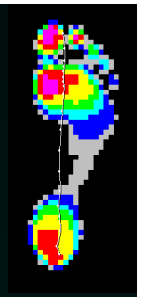


Pied plat abductus
(Too many toes sign)

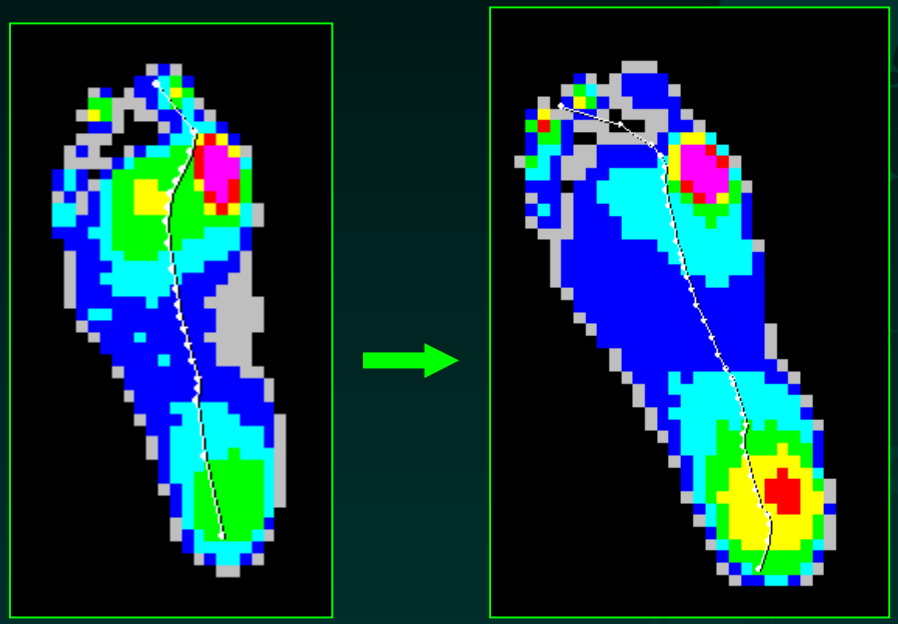


Pied plat valgus

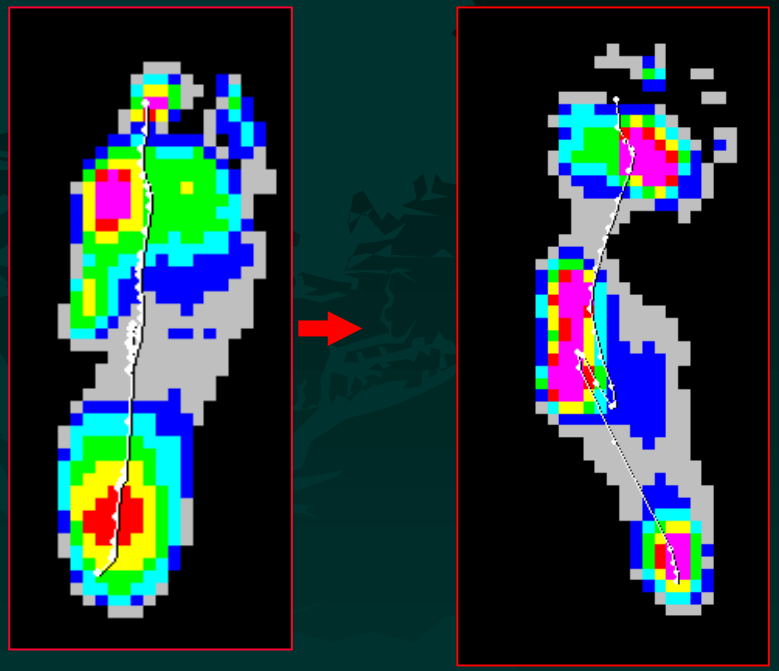
La baropodométrie dynamique dans pied plat valgus



Différent stades



Pied plat abductus



Pied plat valgus

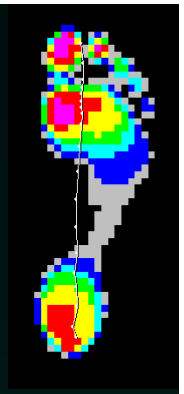
L’analyse vidéo difficilement interprétable

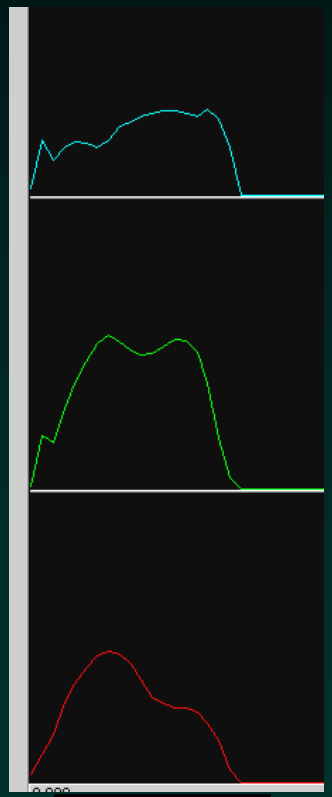
1 pas = 1 seconde

↓

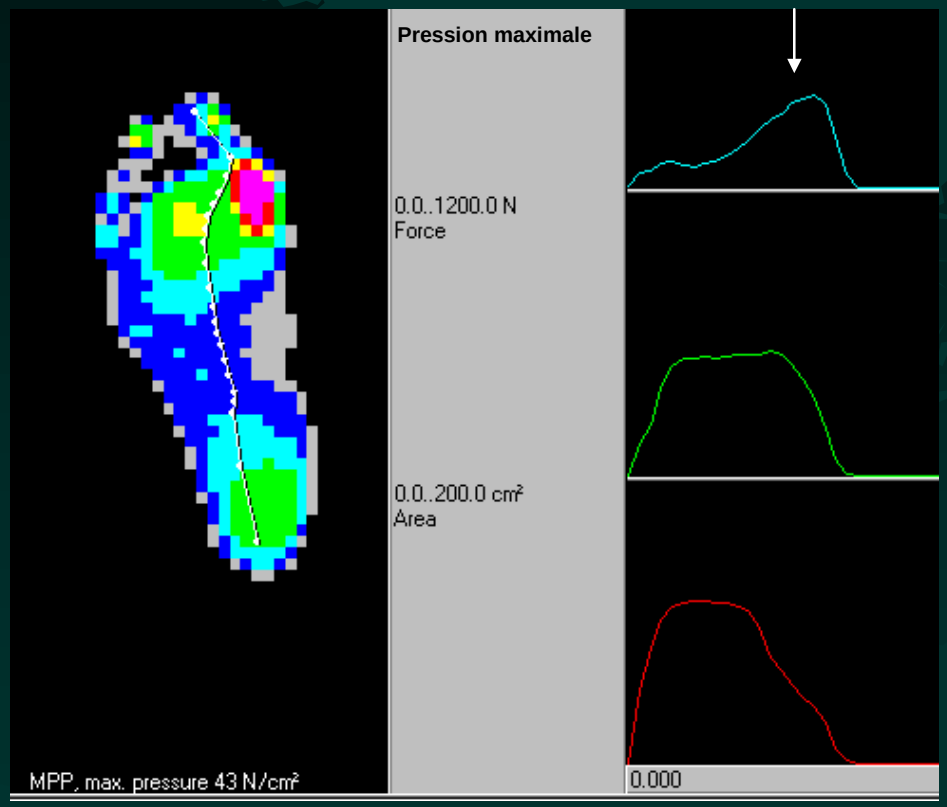
Paramètres d’analyse

1-Les courbes de pression maximale, force et aire d'appui





normal



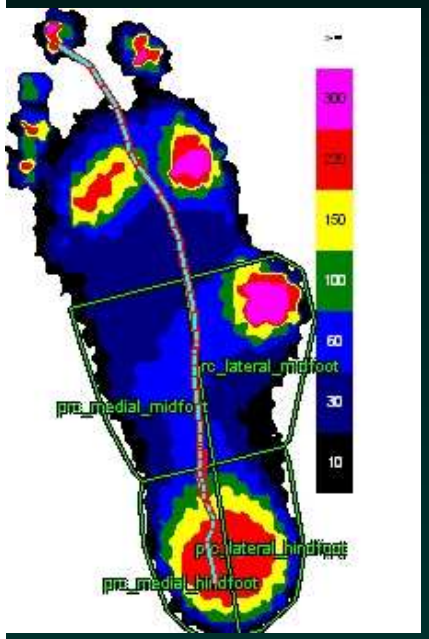
Hyper-pression au lever du talon

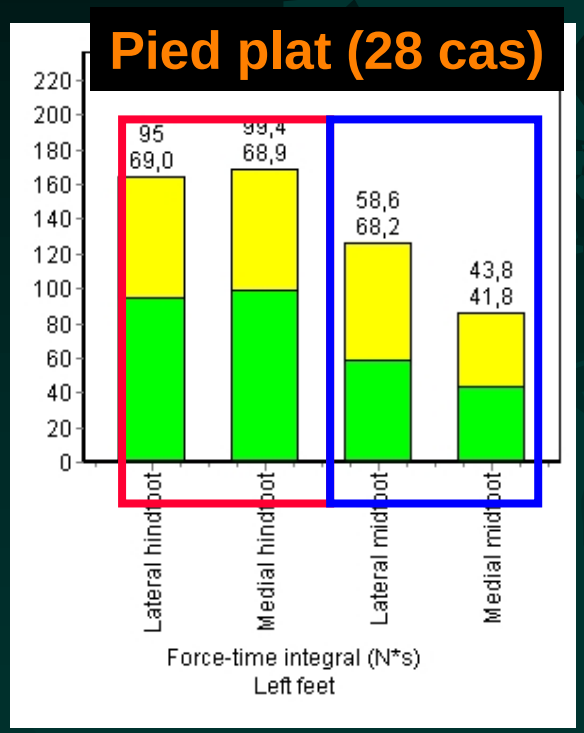
Pas de double dôme

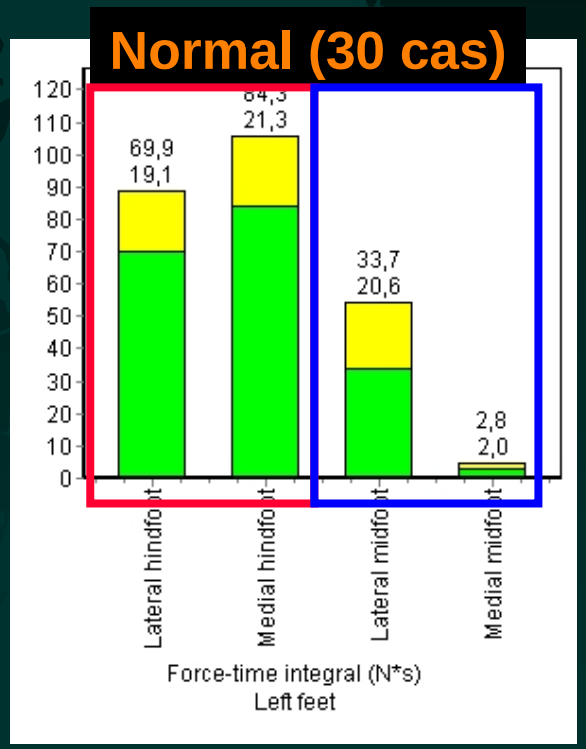
Aire d'appui plus importante et durant plus de temps

temps

2- Les masques : intégrale force temps par zone (aire) d'intérêt.







Moyenne intégrale force temps
dans notre série comparée au normal
(Emed Scientific Meeting Leeds 2004)

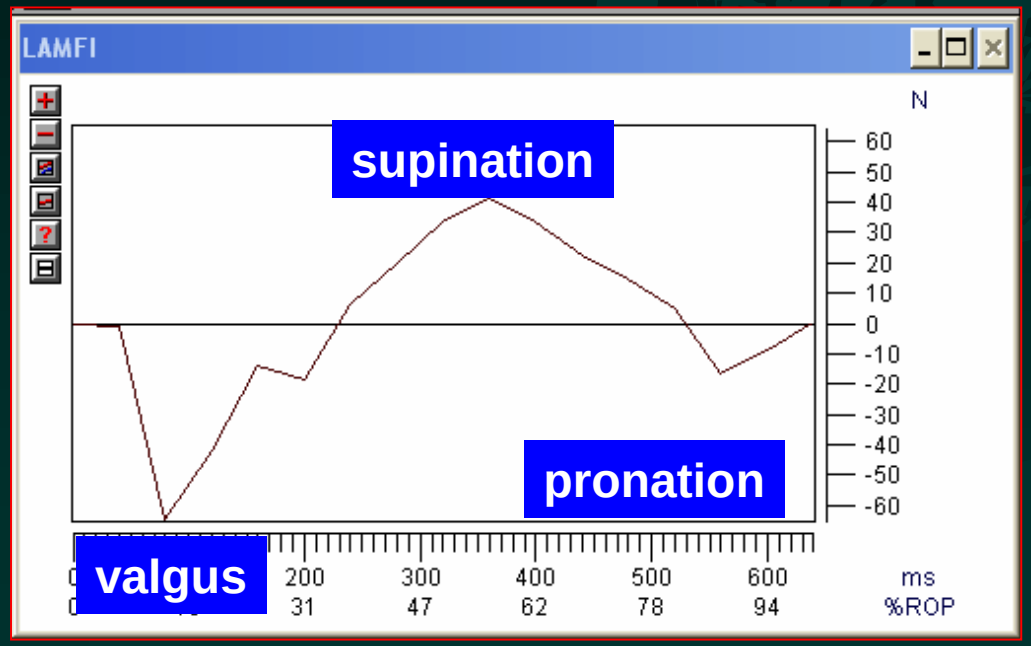
3 – index de force latéro-médiale

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

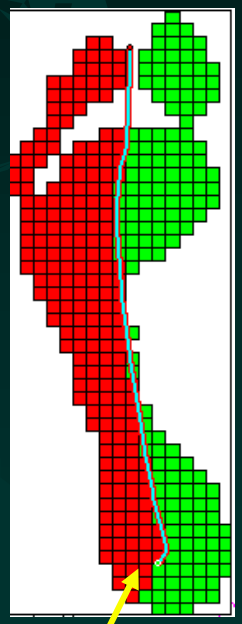
Temps++

Force latérale

Force médiale



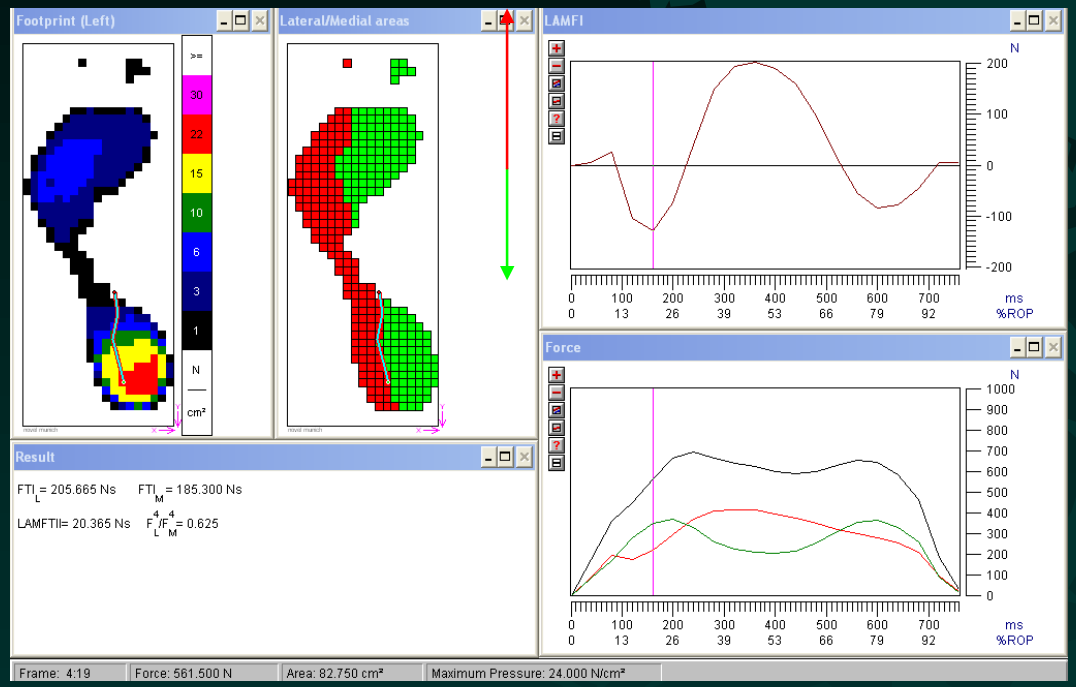
Courbe d'un pied normal

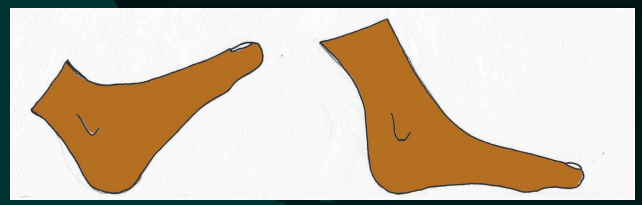


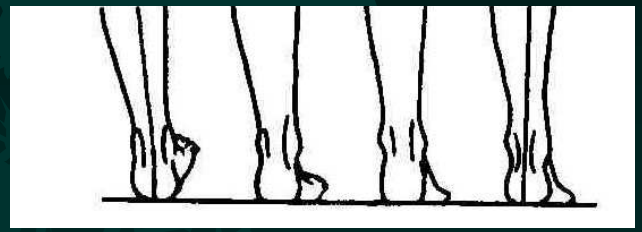
COP

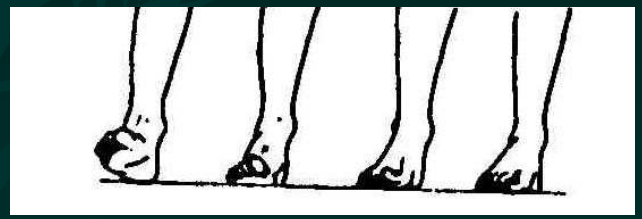
3 – index de force latéro-médiale

D'après Ducroquet





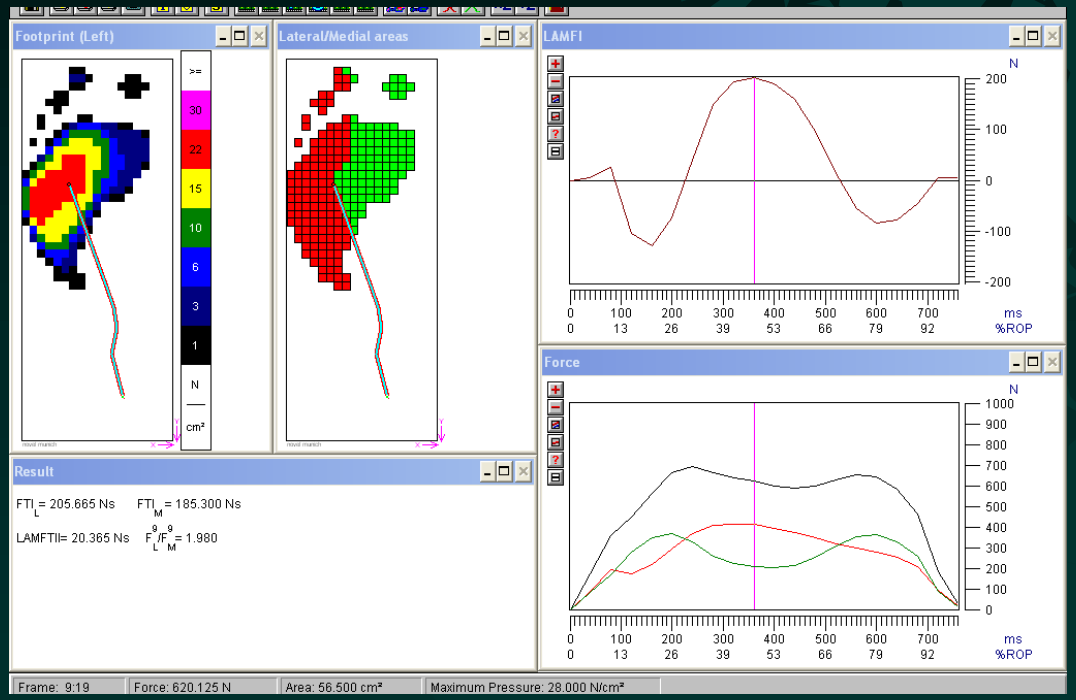


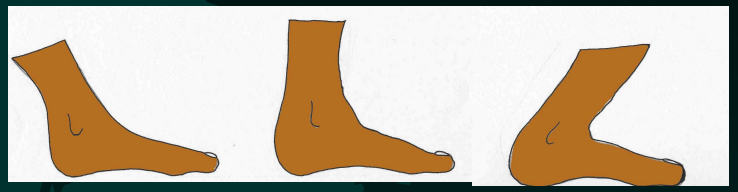


1ère phase = Valgus / descente du pied

Parallélisme entre la courbe IFLM et le COP

3 – index de force latéro-médiale

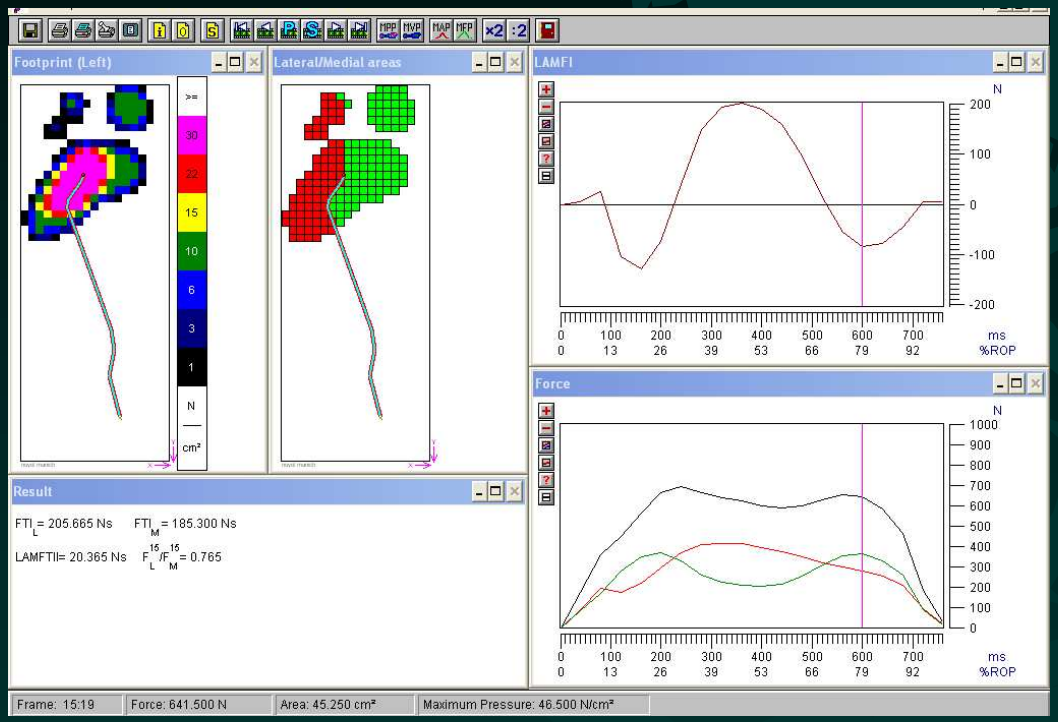


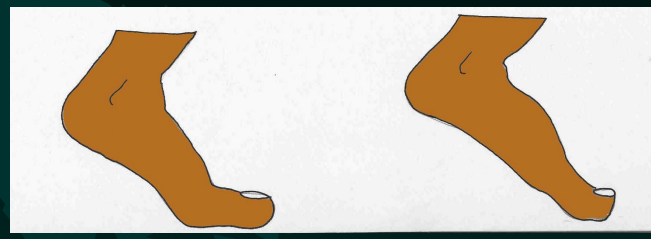


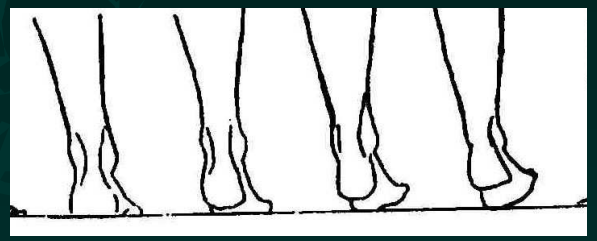
2ème phase = supination

Tibial postérieur

3 – index de force latéro-médiale



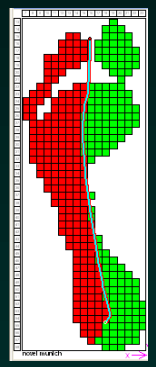




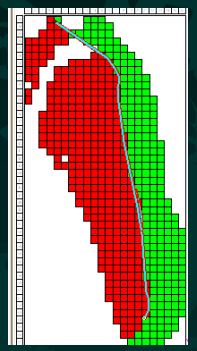
3ème phase = pronation → **fibulaires**

L'index de force latéro-médiale dans le pied plat valgus

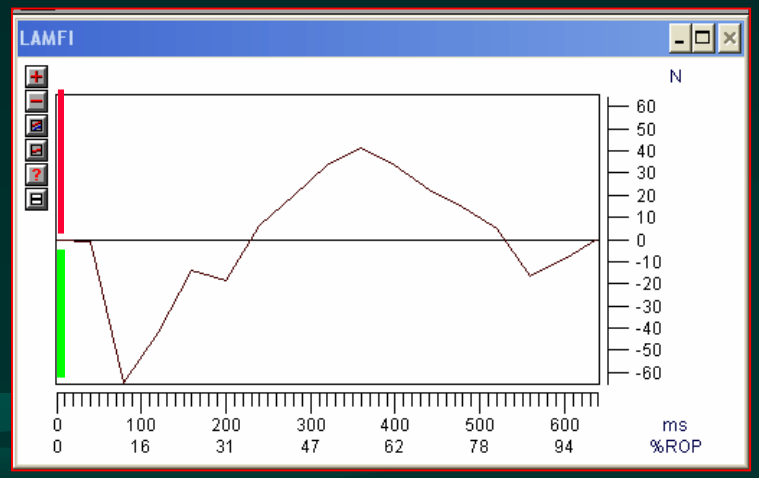
E. Toullec (2005) : Evaluation par baropodométrie dynamique de la force latéro-médiale dans le pied plat valgus sévère avant et après chirurgie, RCO , 91 : 3S129.

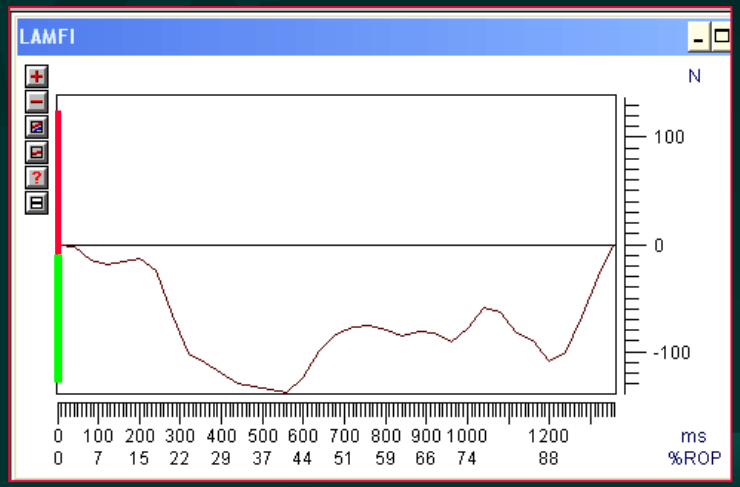


Pied normal

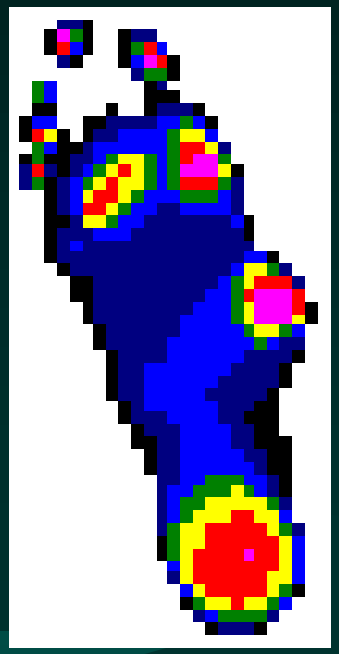


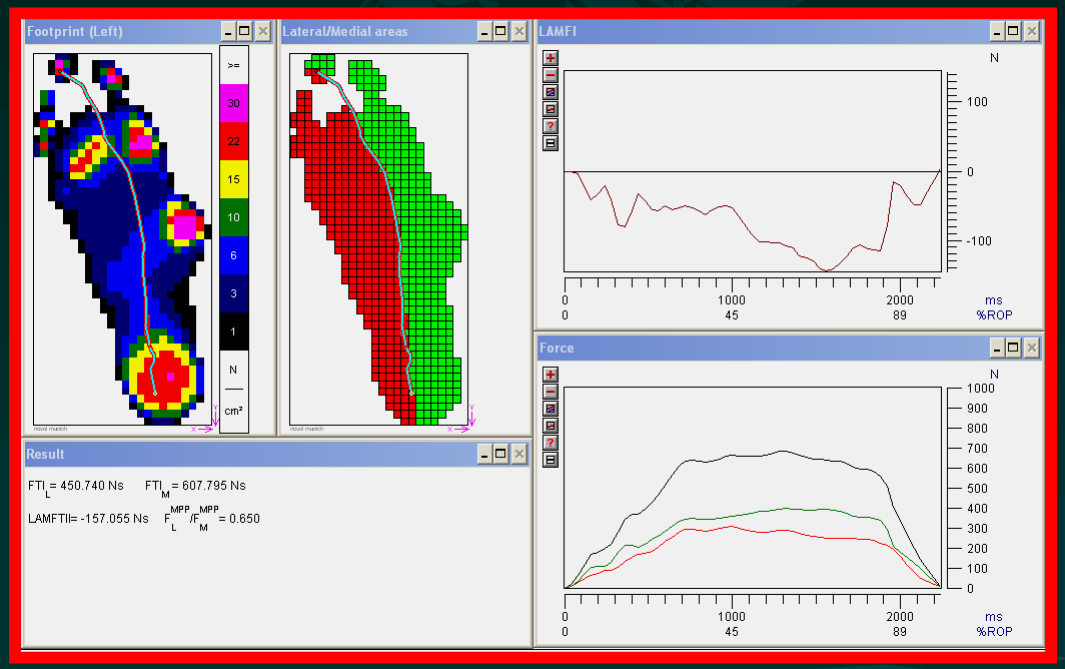
Pied plat valgus



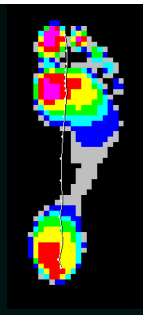


Appui médialisé sur tout le pas = 36%

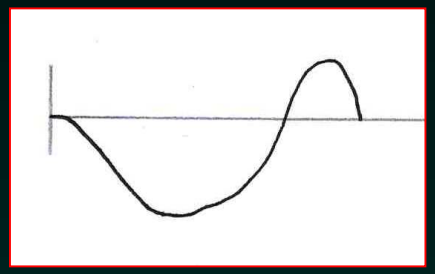




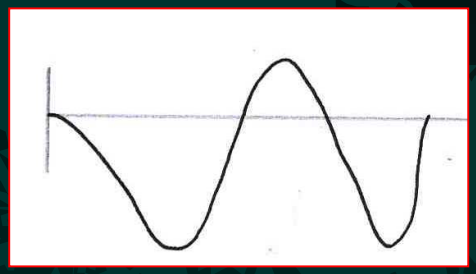
Cependant , cette courbe n'est pas constamment retrouvée



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



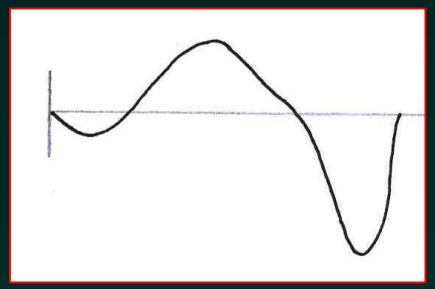
Force médiale
en début du pas
8/28 (29%)
→ valgus AP



Force médiale en
début et fin du pas

1/28 (4%)

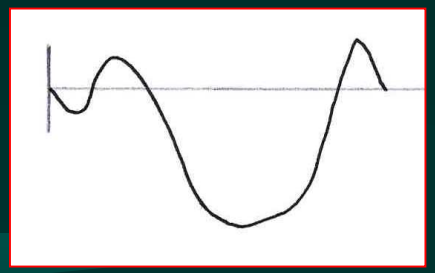
Valgus + hyperpronation



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

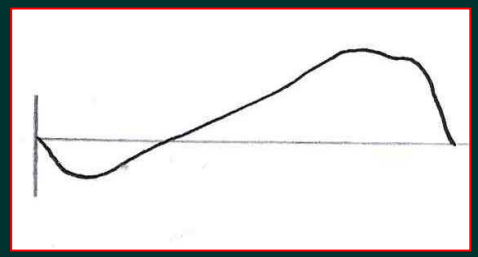
Courbe irrégulière

5/28 (18%)



Force médiale en
milieu du pas

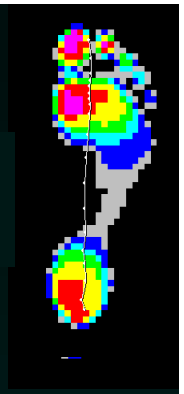
2/28 (7%)

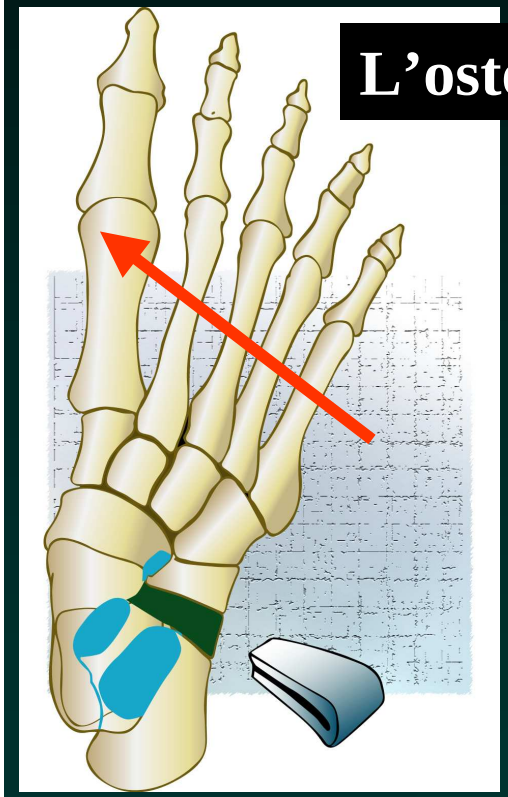


Supination tardive

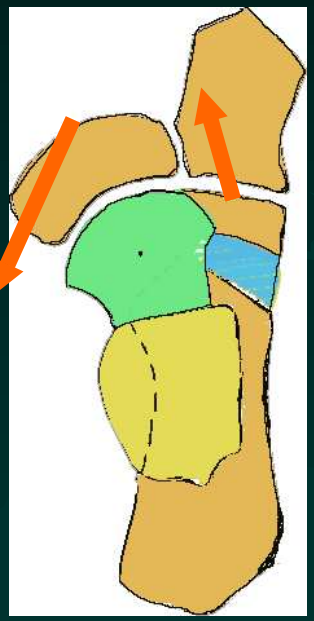
2/28 (7%)

Que se passe t'il après la chirurgie ?





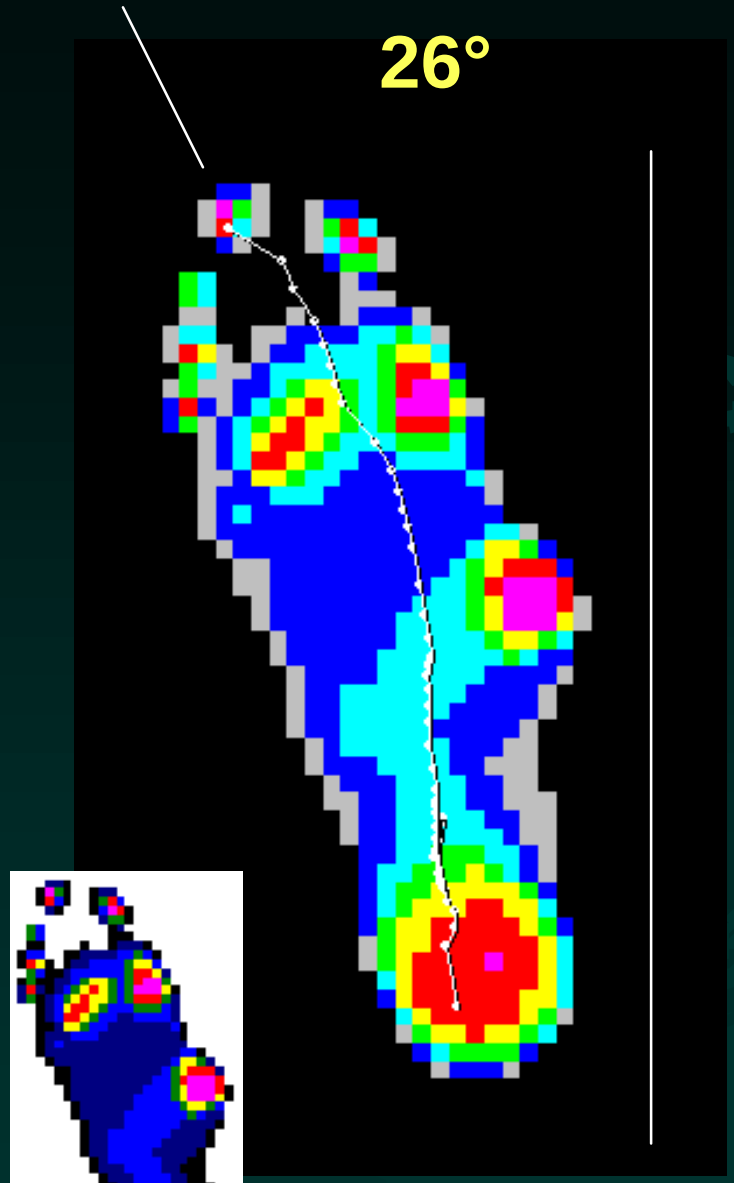
L'ostéotomie d'Evans

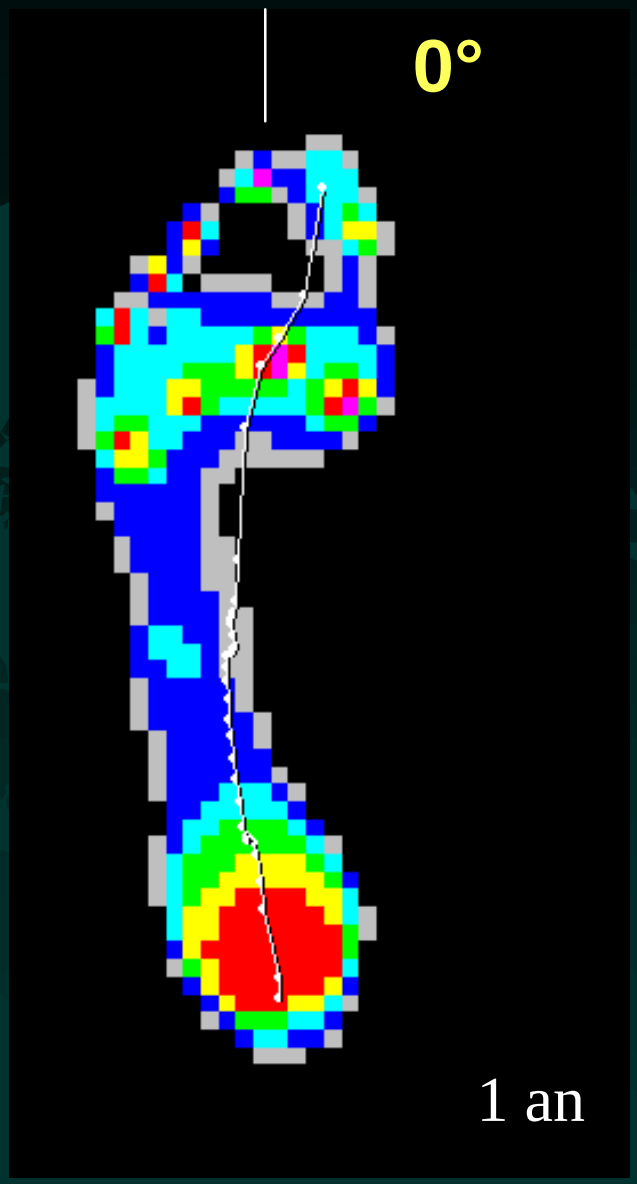


+

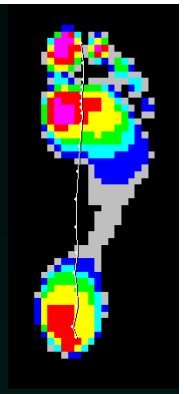
Ostéotomie d'allongement du calcanéum

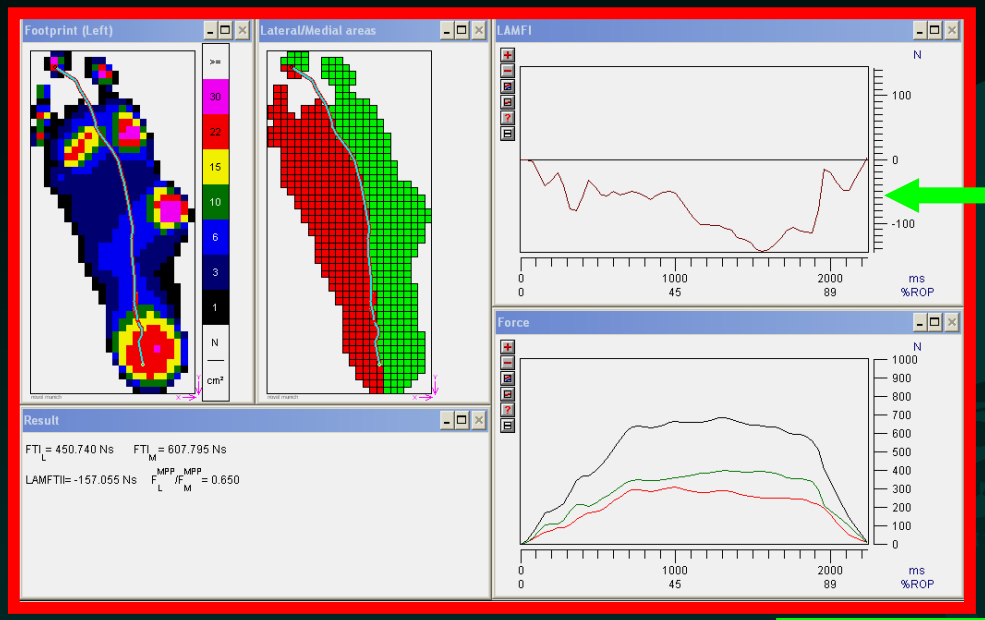
Homme 71 ans – dysfonction TP

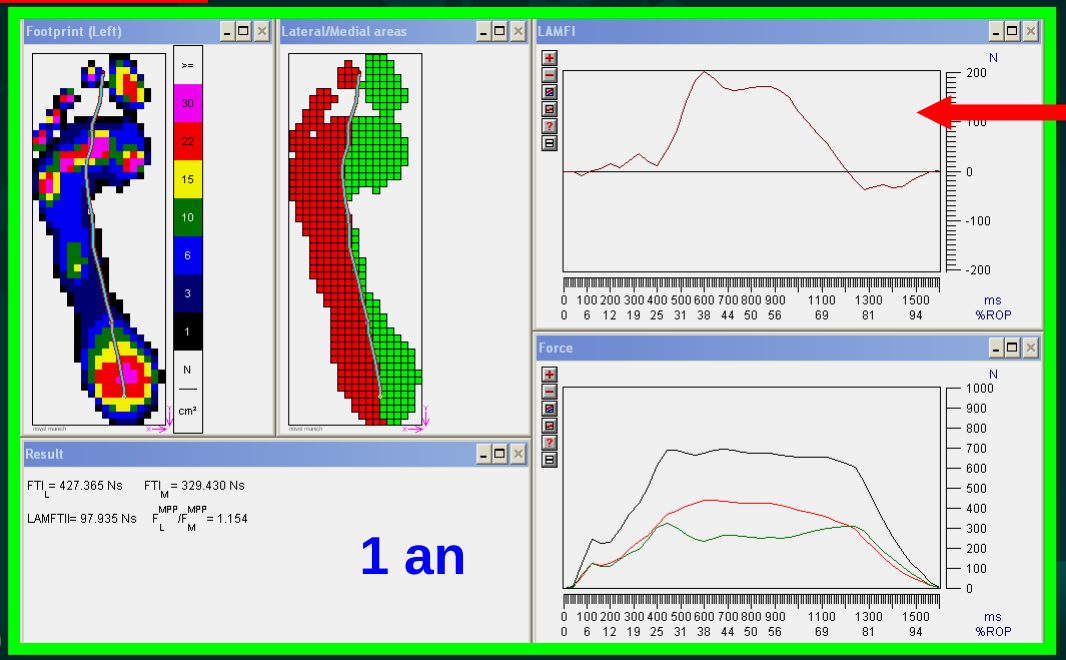

26°


0°
1 an

Modifications des paramètres après chirurgie



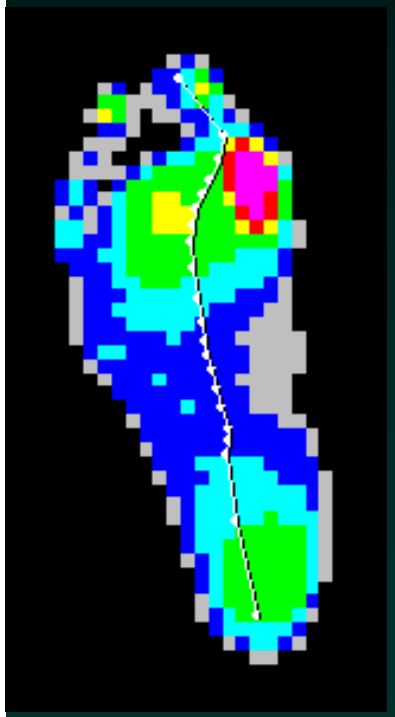


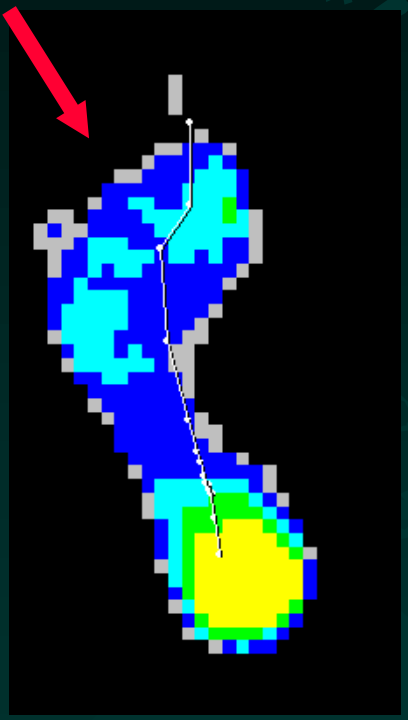


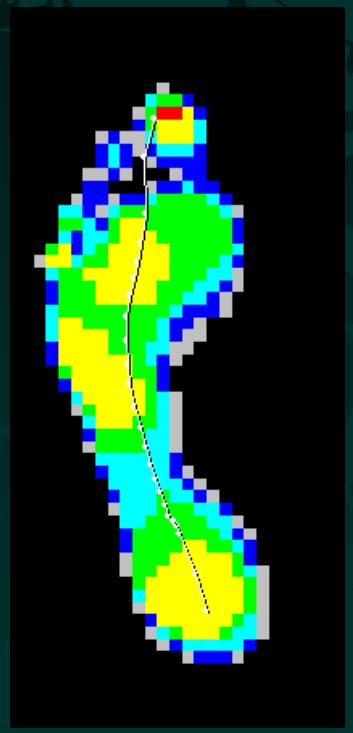
femme 65 ans –
rupture du tibial postérieur :
Evans & scarf
sans réparation du tibial post

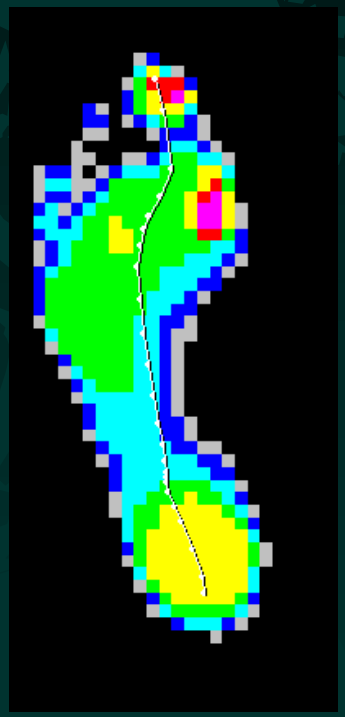
2 ans après

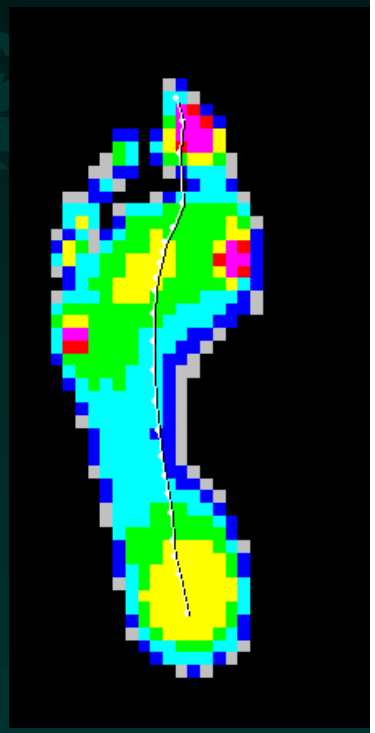
6 ans après



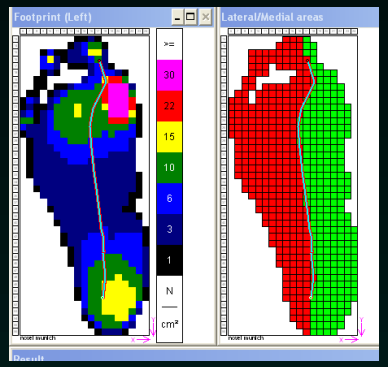




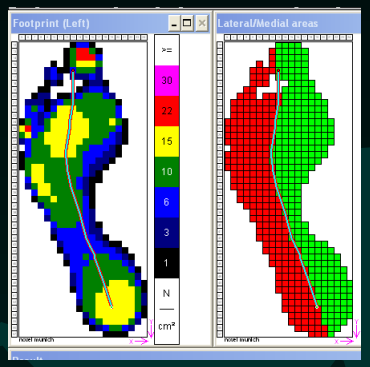




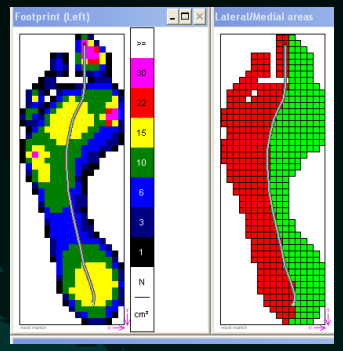
avant | 8 mois | 2 ans | 4 ans | 6 ans



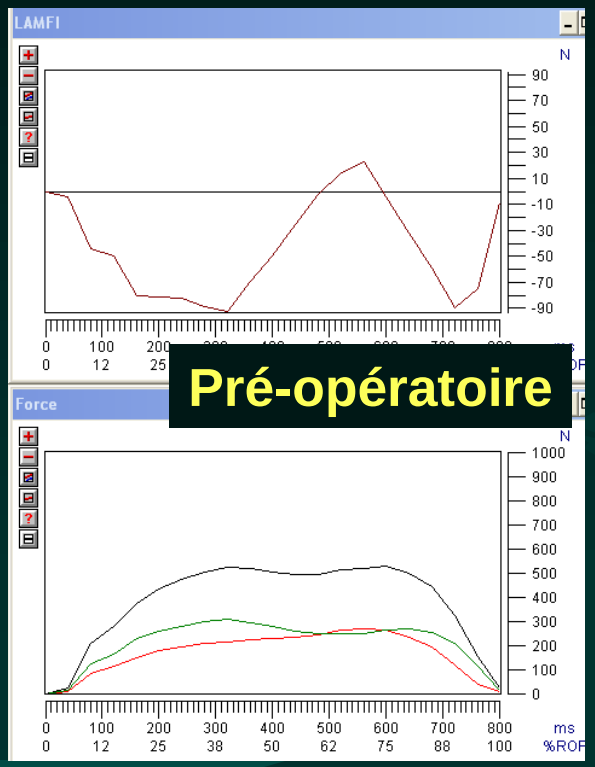
FL/FM = 0,742

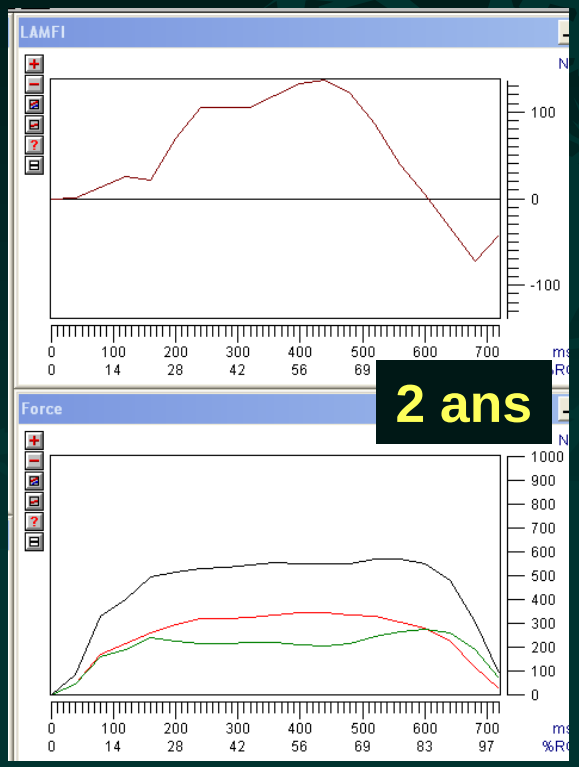


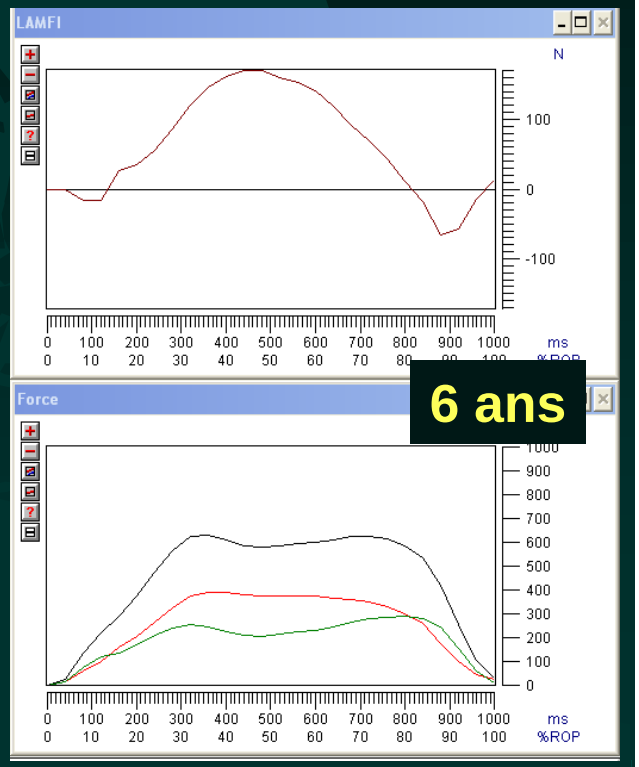
FL/FM = 1,045

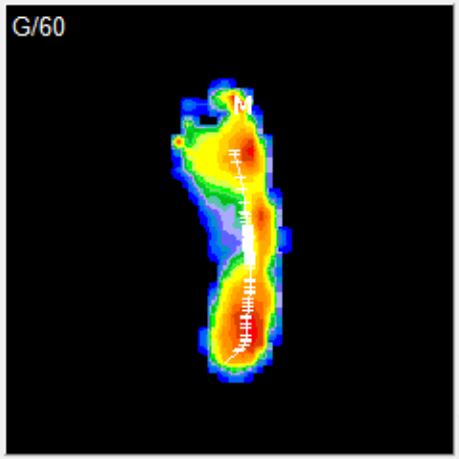


FL/FM = 1,133



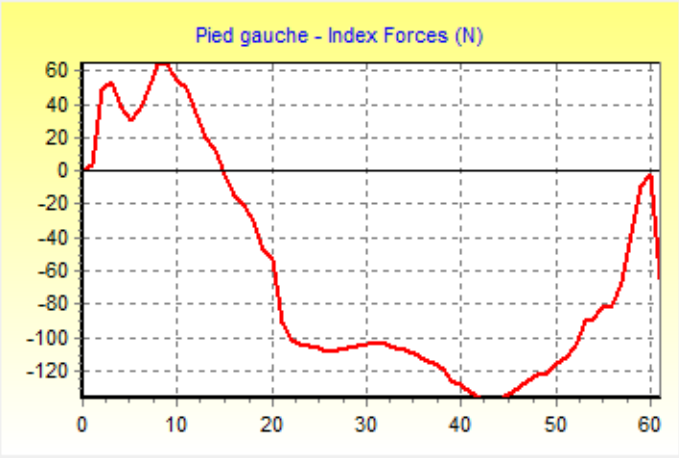




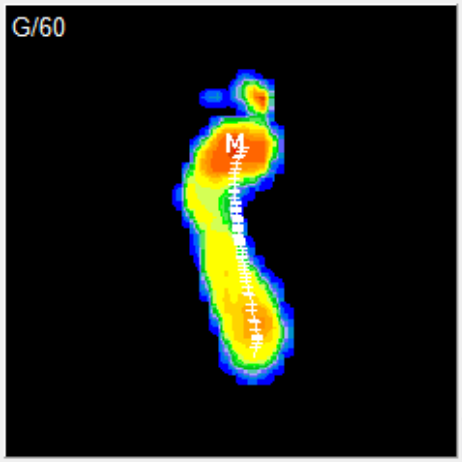


Indice L/M
0.890

Latéral
Médial



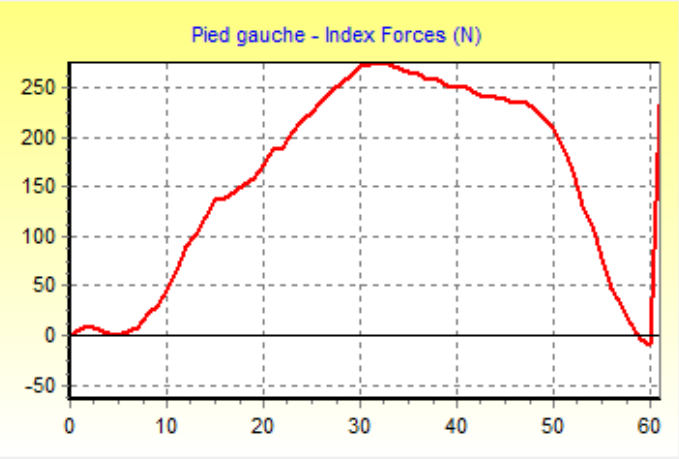
Evans + réparation LLI cheville



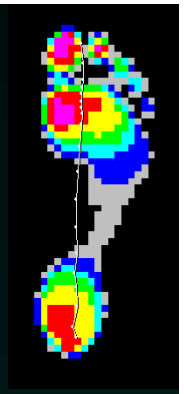
Indice L/M
1.616

1 an

Latéral
Médial

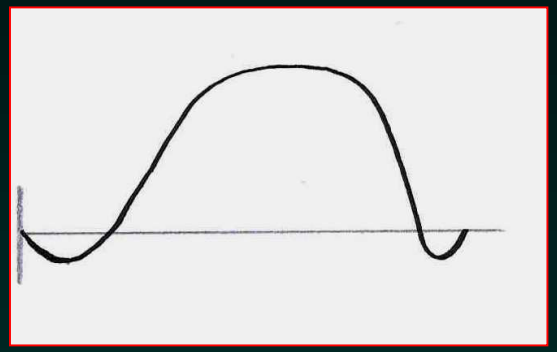


Modifications des paramètres après chirurgie



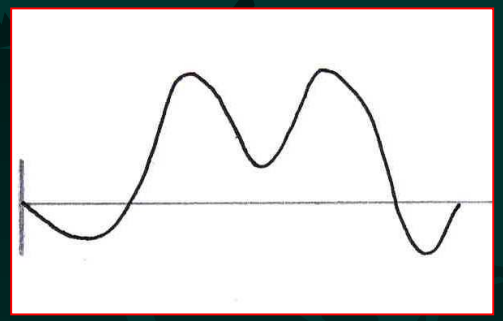
Les courbes LAMFI après chirurgie (suivi > 1 an)

*** Normale 70 % (19/28)**



+

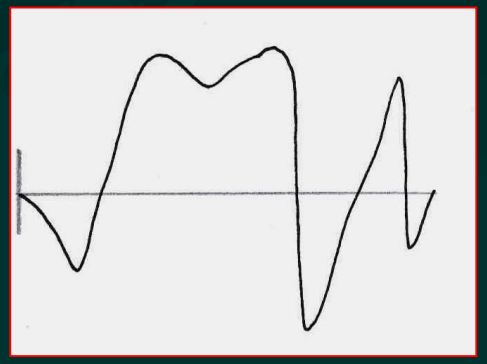
*** Double dôme 10 % (3/28)**

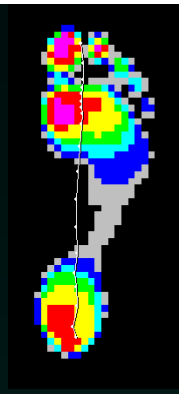


= 80%

Irrégulière 10 % (3/28)

Inchangée 10 % (3/28)



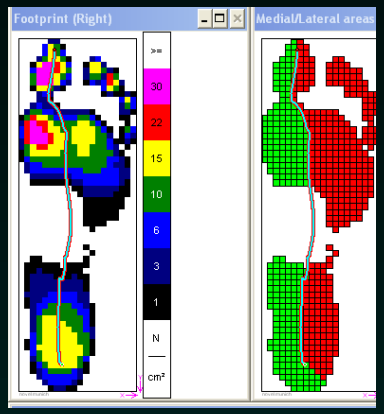


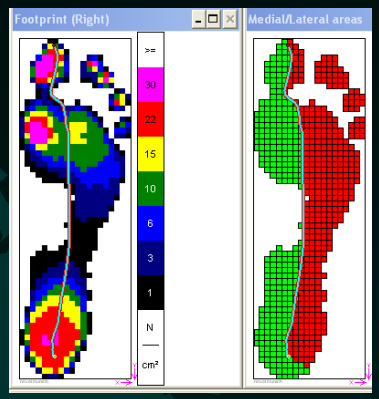
Analyse des résultats

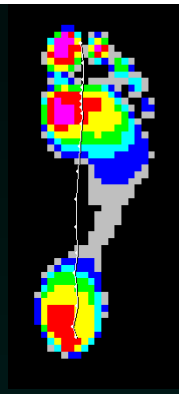
Courbes inchangées (3 cas)

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)

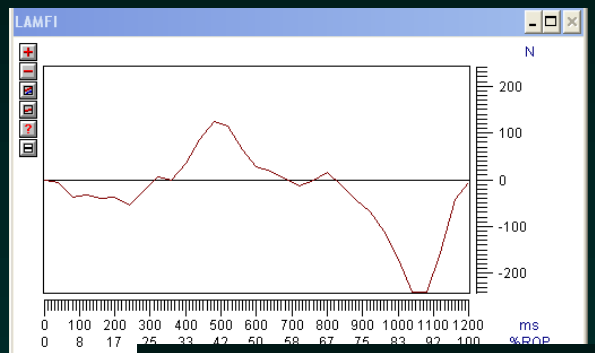


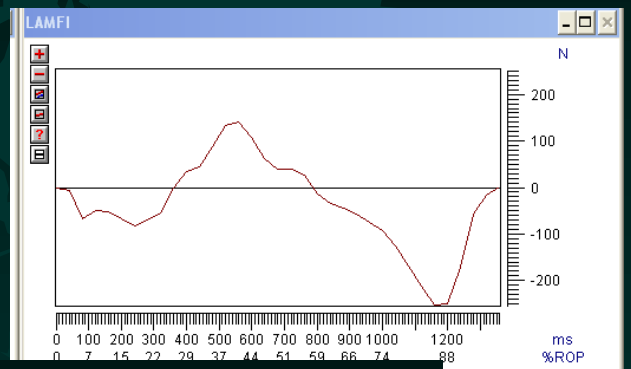




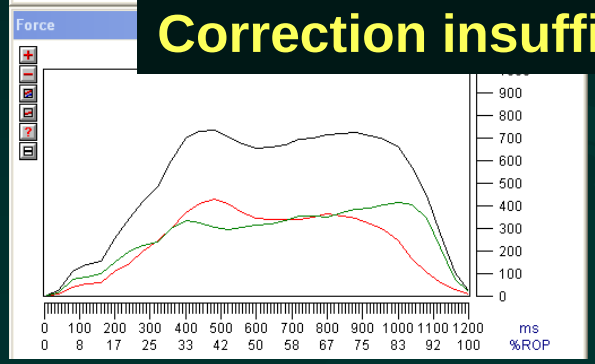
avant

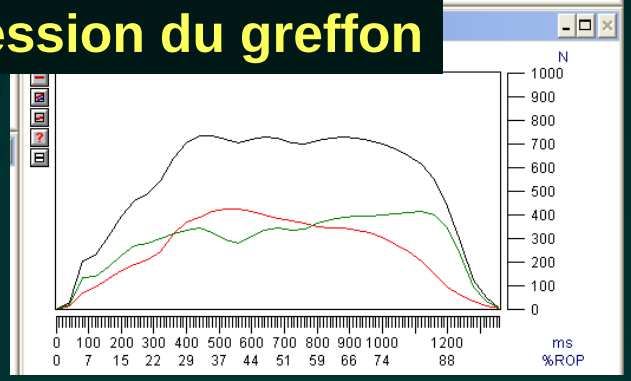
1 an



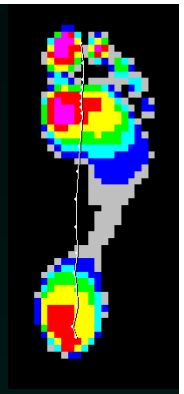


Correction insuffisante par compression du greffon





Modifications des paramètres après chirurgie



Courbes irrégulières (3 cas) :

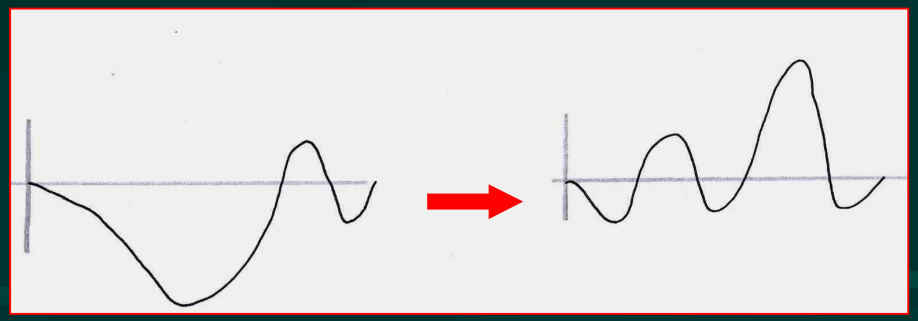
- **résultats moyens dans 2 cas :**

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

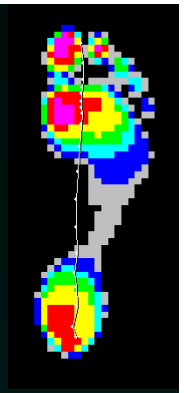
  - laxité tibio-tarsienne associée avec arthrose TN (1 cas)

- **1 bon résultat :**

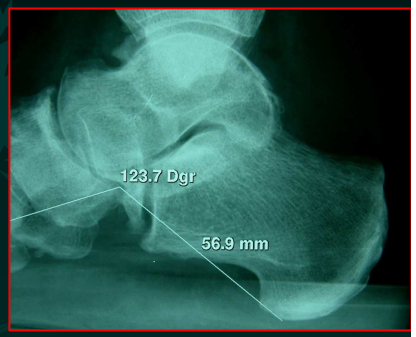
  - séquelle de pied bot varus équin opposé :
    → courbe liée au membre inférieur opposé



Modifications des paramètres après chirurgie



Courbes normales mais résultat non satisfaisant (3 cas) :



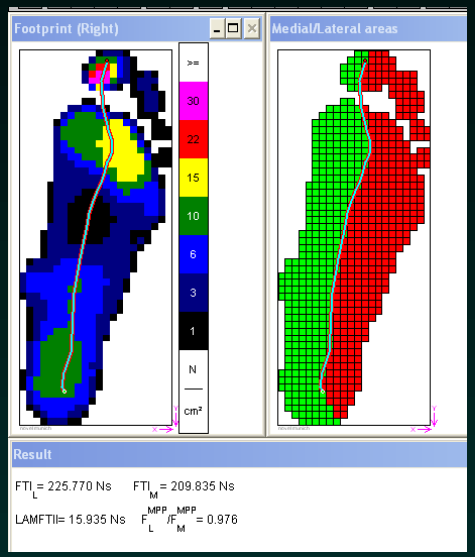
- pseudarthrose de l'ostéotomie du calcanéum

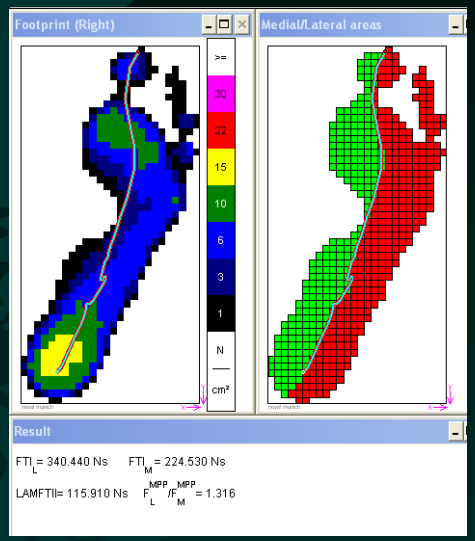
- tassement du greffon (double dôme)
  avec défaut d'appui des orteils

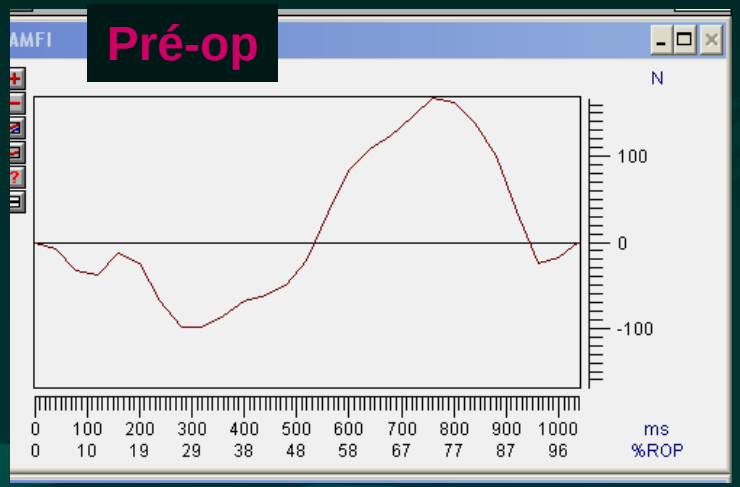
- arthrose MP1 séquelle d'une chirurgie ancienne d'un HV
  traitée par arthrodèse MP1
  + arthrose CC et ST secondaire à 3 ans
  → mauvais résultat

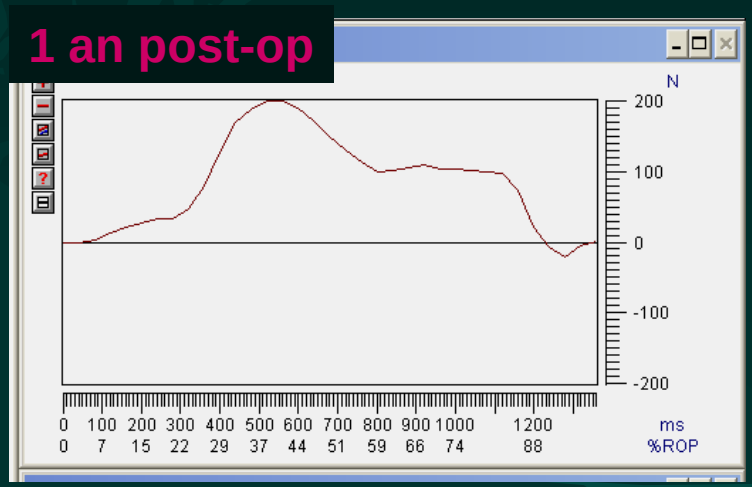
Comparaisons de techniques

Courbe après ostéotomie de translation médiale du calcanéum + transfert FCO

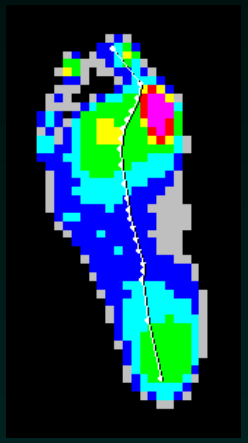


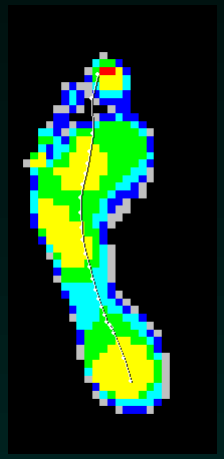


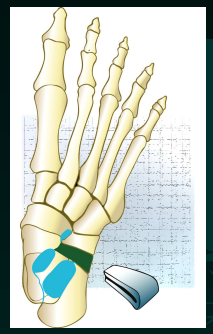




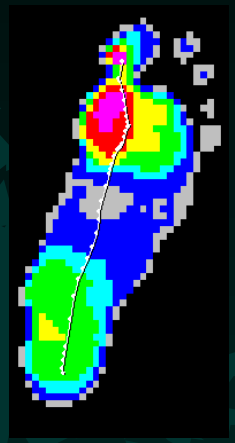
Comparaison des techniques

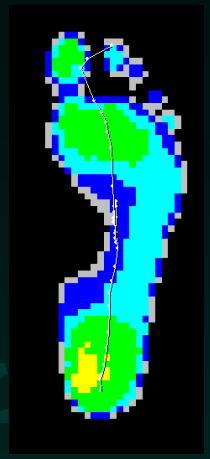






Evans + Scarf M1





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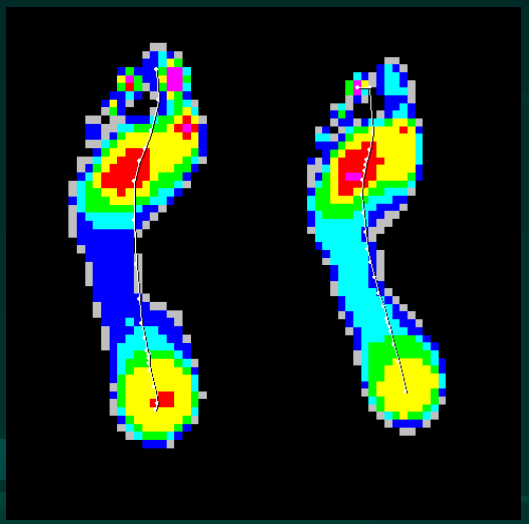
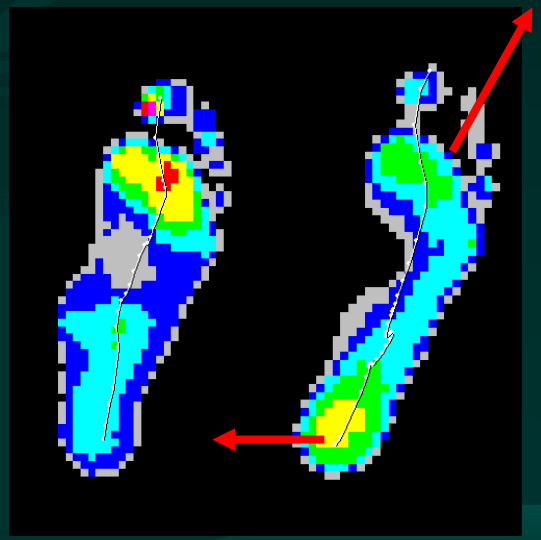
translation médiale + transfert FCO





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 dans la chirurgie du pied plat