



PART 2: RATIONALE & APPLICATION

Pre-manipulative screening



In 1989, Arnetoli & colleagues (Italian neurologists) recommended using VA Doppler in pre-manipulative screening to check for rotational stenosis , because their Doppler studies indicated that rotational stenosis is an independent risk factor for vertebrobasilar stroke.



Screening test criteria

Screening test criteria

- Safe ?
- Inexpensive ?
- Quick ?
- Reliable ?
- Valid ?

Doppler velocimetry is the only test for pre-manipulative screening that meets all these criteria.

Validity & Reliability

Validity: Ability of a new test to detect a condition

Determined by comparing new test with “gold standard”

Sensitivity: Ability of new test to detect abnormality
(100% = no false negatives)

Specificity: Ability of new test to detect normality
(100% = no false positives)

Reliability: Agreement in results of new test for observer(s)

Interobserver reliability: Agreement between 2/more observers

Intraobserver reliability: Agreement between observations
by 1 observer

(100% = total agreement)

Validity & Reliability statistic

Correct statistic to use is:

Cohen's kappa for nominal scores - "kappa" or κ

Much better than sensitivity/specificity because indicates level of concordance beyond that which could occur by chance.

$\kappa = 1.00$: perfect agreement

$\kappa = \text{or } > 0.75$: excellent agreement

$\kappa = 0.4 - 0.75$: fair to good agreement

(Fleiss, 1981)



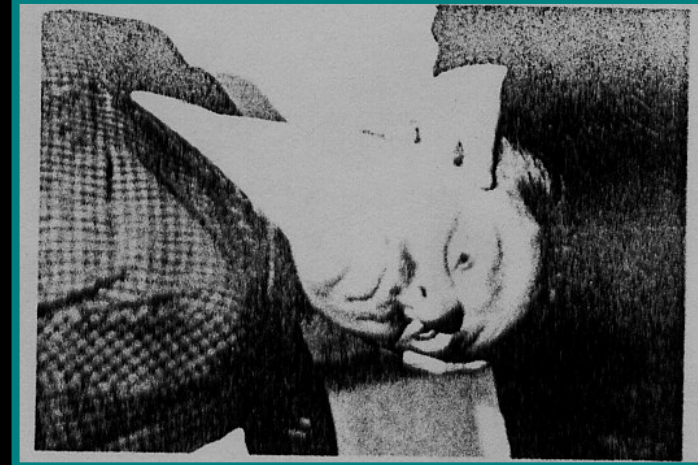
Positional provocation tests

Positional tests commonly used

Rotation / Extension of head

+ ive → dizziness, nausea, nystagmus

relies on: rotational stenosis (<5%) &
inadequate collateral supply (<9% young)



SAFE ? Yes?

INEXPENSIVE ? Yes

QUICK ? Yes

RELIABLE ? Yes

VALID ? No

→ (Rivette et al, 1999)

All properly designed validity studies showed high (eg 100%) false positives or false negatives

VBI provocational tests: Why invalid ?

FALSE + ives → dizziness etc due to non-vascular causes

- Labrynthine

- Cervico-genic (eg “whiplash” injuries)

FALSE – ives → due to collateral circulation

Collateral (back-up) blood supply via - Anastomoses -connecting arteries

Aplasia (absence) and hypoplasia (small calibre, non-functional) VA = 7.5% - 13.7%

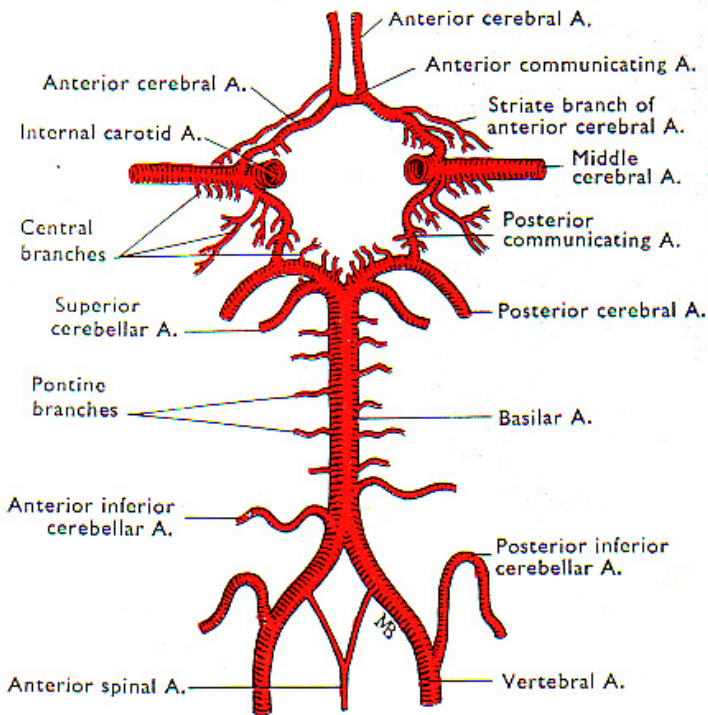
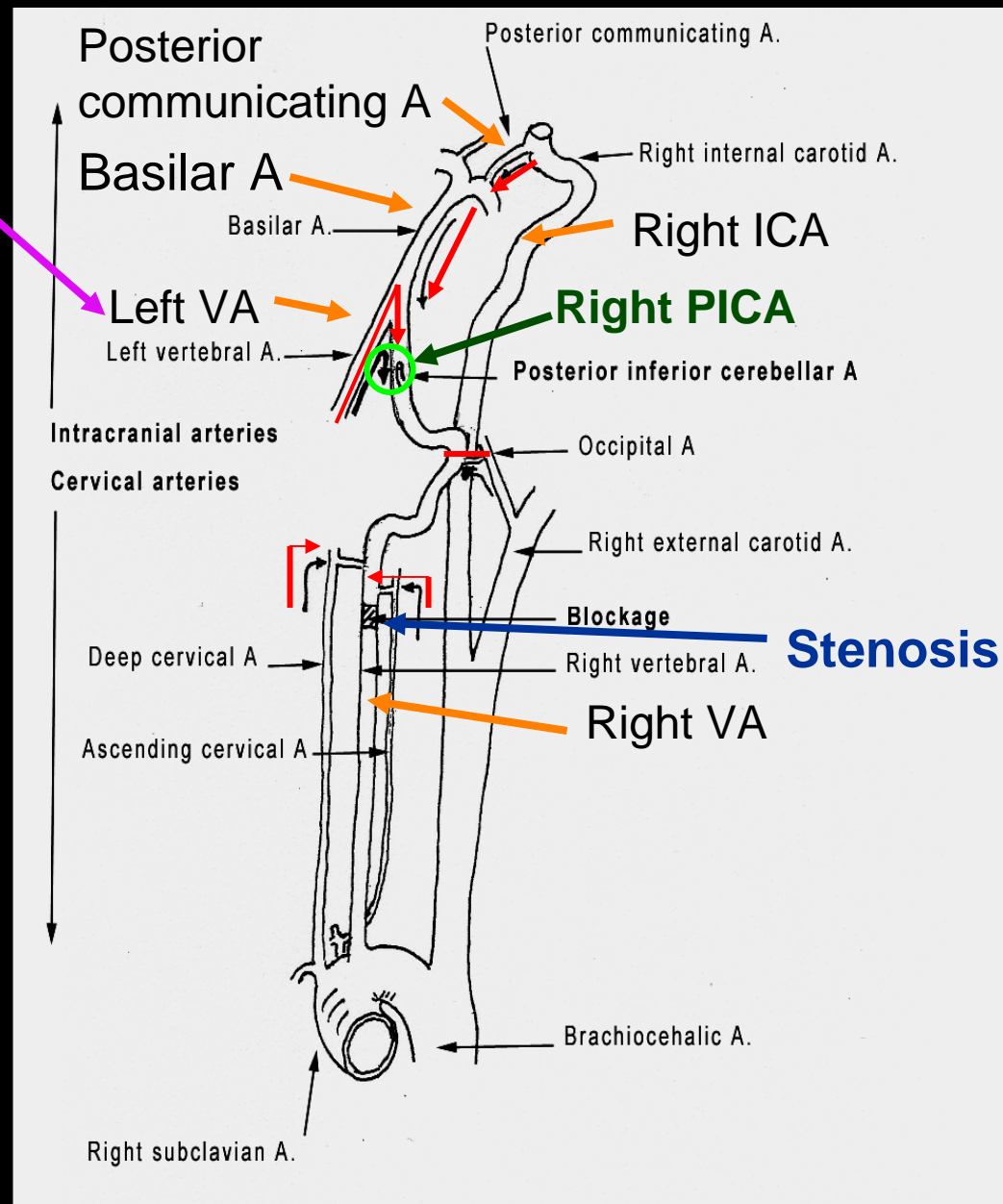


FIG. 187 Diagram of the arteries on the base of the brain including the circulus arteriosus.



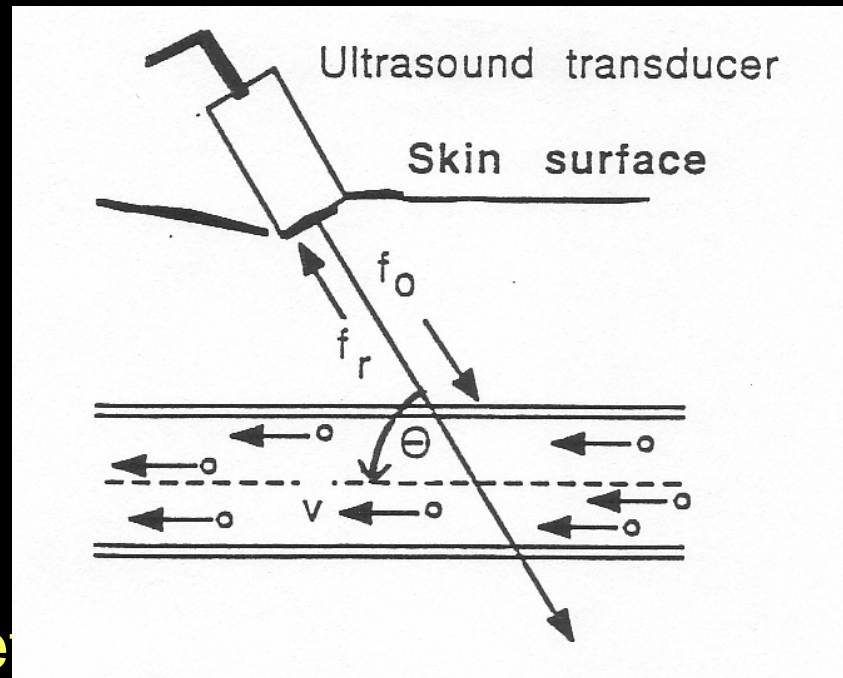


Doppler ultrasound

What is Doppler velocimetry ?

High frequency (eg 4 MHz) sound waves bounced off moving blood.

Change in frequency of reflected waves proportional to velocity of blood.



Doppler effect is similar to the change in frequency of a speeding train as it passes.

Doppler ultrasound (US) velocimetry



Small, hand-held
Doppler velocimeter

SAFE ?

QUICK ?

CHEAP (relatively)

VALID - Patency neutral position ?

- Rotational stenosis ?

RELIABLE ?

(about 2 min)

Yes (about \$1,000)

Yes (compared with
arteriography)

?

?

Doppler (neutral position) Validity trials

High sensitivity stenosis > 60% cross sectional area

85% - 91%

High specificity for normality

94% - 100%

(Kaneda et al, 1977, **Hennerici** et al, 1981, Ringelstein et al, 1985, Karnic et al, 1987, **Armadori** et al 1988)

$\kappa = 0.62 - 0.9$ (Calculated by Haynes, 2002)

4 studies > 0.75

Doppler velocimetry (neck neutral) - high validity

Doppler (neutral position) validity trials-recent

De Bray et al (1997): **78% sensitivity** Doppler vs MRA stenosis related to **VA dissection**.

Concluded that “**Doppler would have detected most of the VA dissection cases.**”

Gobin-Metteil (2006): **58% sensitivity** for dissections. (still indicates that most cases can be detected, although many missed)

Arning (2001): found that for **clear Doppler results**, seen in 85% of 500 VAs, only **0.2% false findings** compared with MRA.

“**Clear Doppler sonographic findings** whether normal or pathological are **still of large diagnostic value**. The sole use of continuous wave Doppler is no longer sufficient in a stroke centre, but **retains its utility in the practitioner’s office.**”



Doppler velocimetry (neck neutral)

-

high validity

VALIDITY TRIAL

AIM: Validity of

Doppler US to detect VA rotational stenosis?

METHOD: Compared : Doppler velocimeter (non imaging)

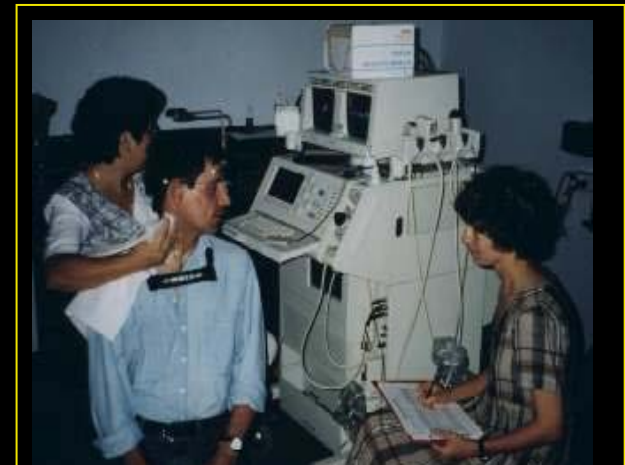
Suboccipital (old) & /or C2 (new)



with duplex US (Doppler + imaging)

Used as affordable “gold standard”

- 20 participants

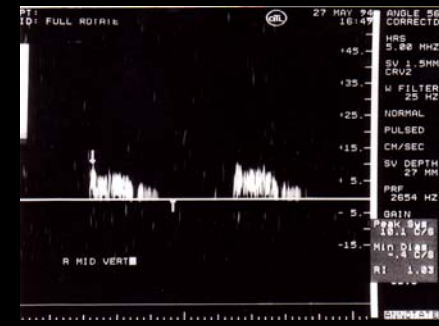
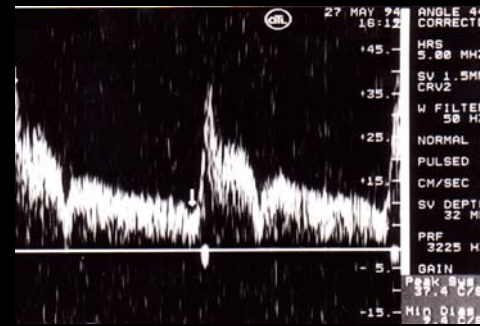
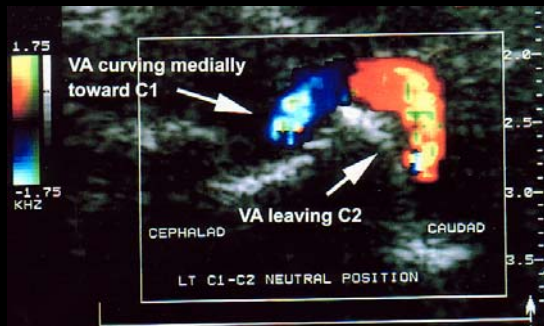


VALIDITY TRIAL

RESULTS :

Doppler velocimeter

Duplex scanning



Suboccipital DOPPLER VS DUPLEX

		DUPLEX	
		Markedly reduced signals	Unaffected signals
VELOCIMETER	Suboccipital only		
	Markedly reduced signals	5	4
	Unaffected signals	0	30

$K = 0.65$ at a 0.01 level of significance

The standard Doppler technique at just the suboccipital level detected all the same 5 +ive cases as did duplex, but did not find all of the 34 -ive cases, duplex detected. There were no false -ive results but there were 4 false + ive results.

NEW DOPPLER VS DUPLEX

		DUPLEX	
		Markedly reduced signals	Unaffected signals
VELOCIMETER Suboccipital & C2	Markedly reduced signals	5	0
	Unaffected signals	0	34

$K = 1.00$ at a 0.01 level of significance

The new combined Doppler technique detected all the same 5 +ive cases as did duplex, and found the same 34 -ive case. No false +ive nor false -ive results.

VALIDITY TRIAL

RESULTS :

- 5 VAs with marked rotational stenosis
- Doppler (combined suboccipital & C2) vs Duplex
100 % agreement ($k = 1.00$)
- Doppler (suboccipital only) vs Duplex
90% agreement ($k = 0.65$)

CONCLUSION :

- Doppler velocimeter valid for VA rotational stenosis
- New combined technique better than old

VA DOPPLER : FALSE FINDINGS

CHANCE OF FALSE – ive < CHANCE OF FALSE + ive

WHY ?

- **VA Doppler signal distinctive (Reduces FALSE – ives)**
- **Difficulties in tracking VA (Increases FALSE + ives)**

SIGNIFICANCE ?

- **Few FALSE – ives → Better detection**
- **FALSE + ives → Not serious, just modify treatment**

Inter – examiner reliability trial

Aim: Determine inter- examiner reliability of Doppler

Method: Compared Doppler results of 2 examiners, one with only 2 hours training in technique.

- 20 participants

Results: 93% agreement ($k = 0.78$)
compares well with inter-examiner reliability ($k = 0.75$) MRA studies
VA rotational stenosis (Weintraub & Khoury, '95)

Note:

Conclusion: Doppler technique reliable, & can be taught to a reasonable level with 2 hours training.



VA Doppler high validity & reliability for rotational stenosis

Doppler velocimeter study – large sample

Aim: Factors affecting positional stenosis –
rotation > lateral flexion? age? gender? side ?

Method: Doppler velocimeter examination

2 groups - 500 chiropractic patients
163 university students

Proportion of positional stenosis for
different groups.

Data analysis: Fisher's exact test of proportions

Significance level set at 0.05 (ie 95% chance that
within error margin, result represents the true
proportion)

Doppler velocimeter study – large sample

Results:

8.8% of 1,324 examinations no VA signal neck neutral
-in line with 7.5%-13.7% VA aplasia/hypoplasia (Argenson et al,1980)

Significant differences

- rotational stenosis (4.2%) > lateral flexion (0%)
- students (young adults) > patients (older)
- right VA > left VA (male students)

Almost significant differences


- right VA > left VA (students & total sample)
- women patients > male patients

Doppler velocimeter study – large

sample

Conclusions:

- Further evidence that Doppler can assess VA patency regarding aplasia/hypoplasia & hence collateral circulation.
- Rotation more likely to place stress on VA s than lateral flexion.
- Younger adults (ie, <45 yrs) more likely to have VA rotational stenosis than older chiropractic patients.
- Right VAs more prone to rotational stenosis than left - but not necessarily at more risk of injury.



CLINICAL RELEVANCE & GUIDELINES

Proposed clinical guidelines: neutral position

Doppler able to assess VA patency - **if a VA not patent use only low force techniques eg STT, Activator.**

Aplasia/hypoplasia → possible **inadequate collateral circulation** in event of VA dissection ↑ risk of stroke.
(Schievink, 2001)

Can detect high grade stenosis with **large VA dissections**, but not for small. -

Can't Dx dissection; **alerts to possible dissection** when pain indicative &/or vertebro-basilar insufficiency →
MRA or helical CT scanning needed.

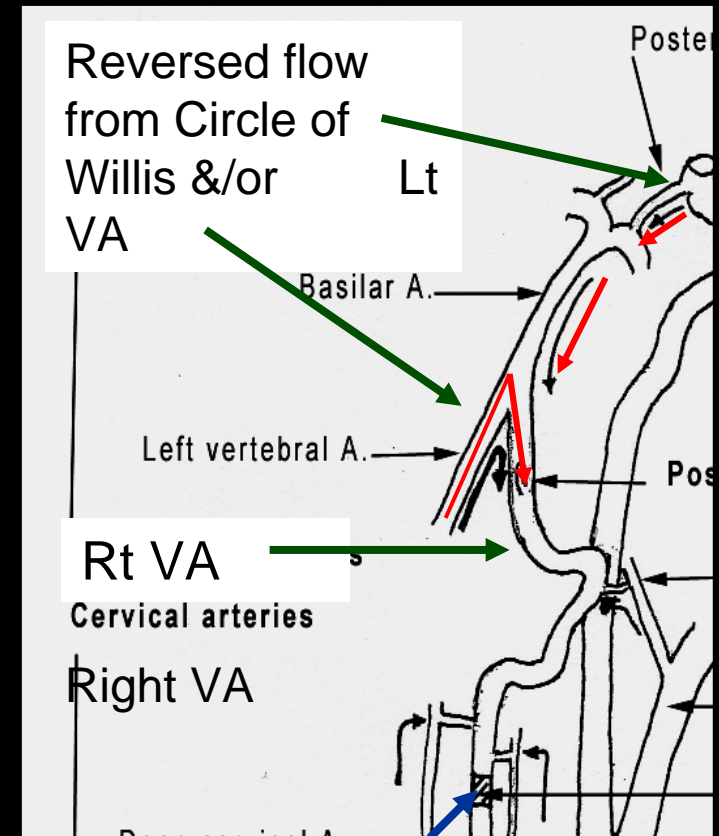
Major neurological deficits (eg 5 Ds And 3Ns) require **urgent referral** regardless of Doppler findings.

Clinical relevance & guidelines: neutral position

Reversed VA blood flow indicates collateral supply from other arteries

→ VA (or Subclavian A) occluded.

→ possible dissection or other major pathology → urgent referral



Occlusion Right VA due to - atheroma ?- older
- dissection? - younger

Proposed clinical guidelines: neutral position

Abnormal Doppler signals when previously normal (pain suggestive of possible dissection) →

Check blood pressure

change from BP taken previously →
→ urgent hospitalization (prevent stroke)

- If no major
assume dissection

-If hypotensive when previously normal/hypertensive & no neurological problems → monitor patient & medical referral.

Suspect dissection patients ambulanced to hospital in case stroke ensues. Spasming → difficulty extracting from car

Proposed clinical guidelines: neck motion

Cervical rotation greater stress on VA than lateral flexion → lateral flexion manipulation safer, No full rotation techniques

Detection of rotational stenosis → No rotation in manipulation. Advise patient - careful with rotation; avoid prolonged or rapid full rotation.

If stenosis occurs early in rotation or during lateral flexion → Severe biomechanical abnormality → No manipulation.

Summary

Link between some stroke cases & cervical manipulation unproven, but evidence mounting.

Post manipulation stroke is rare but not so rare as to be insignificant.

Chiropractors ethically & legally required to use reasonable, best evidence approaches that aim to reduce risk of patient injury.

Doppler US velocimetry is the only test on VAs, available to chiropractors, that satisfies all the criteria for pre-manipulative screening.