

ORIGINAL

Echogenicity of needles: a comparative *in vitro* study

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ABSTRACT

Aim: Needle visualization is important for safe and successful ultrasound-guided peripheral nerve block. However, accurate and consistent visualization of the needle tip can be difficult to achieve. A number of previous studies have analyzed the ultrasound properties of needles and have reported reduced visibility with steeper insertion angles. Anecdotal evidence suggests that the converse is true with the newer echogenic needles on the market.

The aim of this study was to analyze the echogenic parameters of 4 needles currently on the market and assess whether any advances in needle echogenicity have been achieved in the last few years.

Methodology: By using a water bath and a M-Turbo Sonosite machine with a HFL probe we analyzed the echogenic versions of the Pajunk, Vygon, BBraun and Polymedic needles. The needles were inserted to 4cm and pictured at 0, 30, 45 and 60 degrees insertion relative to the surface. We measured pixel intensity, being defined as the grey scale value from 0 (black) and 255 (white). For ease of comparison the value obtained was converted to a percentage of 255 (white 100% and black 0%).

Results: Our study shows that all four needles were clearly visible at all 4 angles with good tip visibility. Surprisingly and contrary to previous results, needle visibility increased with steeper insertion angles. The brightest images were recorded at 60 and 45 degree insertions. Of the four needles Pajunk and Polymedic were the most echogenic.

Discussion: Our results have shown a significant improvement in needle visibility at steeper angles of insertion. Previous studies reported loss of needle visibility above 45 degrees. Our study shows that the new needles are clearly visible at 60 degrees and are more echogenic than when viewed at 10 degrees.

Our study shows that the echogenic properties of the current needles are superior to those of previous models and will no doubt continue to improve as the popularity of regional anesthesia grows.

Key words: Ultrasound. Needle. Echogenic. Regional anesthesia.

RESUMEN

Objetivo: La visualización de la aguja es importante para la realización de un bloqueo de nervio periférico seguro y eficaz guiado por ecografía. Sin embargo, la identificación precisa y evidente de la punta de la aguja puede ser difícil de obtener. Existen varios estudios que han analizado las propiedades ecográficas de las agujas y han demostrado la reducción de visibilidad de la misma con ángulos de inserción más pronunciada. Parece que sucede lo contrario con las agujas ecogénicas que han aparecido en el mercado, si bien son aún muy escasos los estudios que lo señalan.

El objetivo de este estudio fue analizar los parámetros ecogénicos de 4 de las agujas que hay actualmente en el mercado y determinar si se ha avanzado y en qué grado en la adquisición de nuevas propiedades ecográficas de las agujas en los últimos años.

Metodología: Mediante el uso de un recipiente de baño de agua y una máquina de ecografía M-Turbo de Sonosite con una sonda HFL analizamos las versiones ecogénicas de las agujas: Pajunk, Vygon, BBraun y Polymedic. Las agujas se insertaron unos 4 cm y se fotografiaron sus imágenes ecogénicas a los 0, 30, 45 y 60 grados de inserción en relación a la superficie, respectivamente. Se midió la intensidad de los píxeles, que se define como el valor en la escala de gris desde de 0 (negro) a 255 (blanco). Para facilitar la comparación entre ellas, el valor obtenido se convirtió en porcentaje de 255 (blanco 100% y 0% negro).

Resultados: Nuestro estudio demuestra que las cuatro agujas eran claramente visibles en los cuatro niveles de angulación y que había buena visibilidad de la punta de las mismas. Sorprendentemente, y contrariamente a los resultados anteriores, la visibilidad de la aguja se incrementó con ángulos de inserción más pronunciada. Las imágenes más intensas y brillantes se obtuvieron con 45 y 60° de inserción. De las cuatro agujas, la de Pajunk y Polymedic fueron las más ecogénicas.

Discusión: Nuestros resultados han demostrado una mejora significativa en la visibilidad de la aguja incluso con ángulos de inserción más pronunciados. Estudios previos habían documentado la pérdida de visibilidad de la aguja en angulaciones mayores a 45°. Nuestro estudio revela que las agujas nuevas son claramente visibles a los 60 grados y que son más ecogénicas que cuando se ven a 10 grados. Nuestro estudio determina que las propiedades ecogénicas de las agujas actuales son superiores a los de modelos anteriores y que sin duda seguirán mejorando a medida que la popularidad de la anestesia regional crezca.

Palabras clave: Ultrasonido. Aguja. Ecogénica. Anestesia Regional.

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INTRODUCTION

Regional anaesthesia is enjoying resurgence in popularity much of which is attributable to the introduction of affordable, high resolution and portable ultrasound machines. Direct visualization of the anatomy with ultrasound either in plane (long axis; longitudinal) or out of plane (short axis; transverse cross sectional) reduces many of the risks associated with traditional regional anaesthesia. Benhamou et al (1) reported a 12 fold increase in regional anaesthesia over the last 16 years and with an increasingly aging and obese population the popularity of ultrasound guided regional anaesthesia is likely to continue.

The major limitations of ultrasound-guided blocks are technical, including the angle of incidence, needle visualization, and artifacts. Needle visualization is important for safe and successful ultrasound-guided peripheral nerve block. However, accurate and consistent visualization of the needle tip can be difficult to achieve. Previous investigators have studied ways to improve visualisation including roughening the needle surface (2), staccato movement (3), and priming with air or water (4).

Manufacturers are fast realising the potential of investment in regional anaesthesia and new highly echogenic needles are now appearing on the market. A study by Ingeborg Schafhalter-Zoppoth et al (4) published in 2004 assessed various factors that influence ultrasound visibility of needles. Regional block needles were inserted into tissue equivalent phantoms at angles from 0° to 65° relative to the phantom surface and the echogenicity assessed. One of their findings was that needle tip and shaft visibility decreased with steeper angles. These findings were mirrored in studies by Kremer Nichols BS et al (5) and Maecken T et al (6). There has since been significant advances in the development of needles and the aim of this study was to compare the echogenicity of four of the latest needles currently available on the market and assess whether any improvements have been made.

METHODOLOGY

Equipment

A water bath was used in place of a phantom. Imaging was performed with M-Turbo Sonosite machine with a HFL probe.

Needles

The echogenic versions of the following needles were used in this study: Pajunk, Vygon, BBraun and Polymedic. The properties of the needles can be found on the table I.

TABLE I

NEEDLE PROPERTIES

Needle	Manufacturer	Diameter	Length (mm)	Bevel
Polymedic hybrid	Temena	22	50	30
Pajunk	Sonoplex	22	50	30
B Braun	Countiplex D	20	55	15 degrees
Vygon	Ultrasound needle	22	50	30 degrees

The needles were individually inserted into the water bath at 4 cm depth and pictured at 10°, 20°, 45° and 60° relative to the surface. A set square application on an i-phone was used to place the needle at the correct angle. The angle was later confirmed on Photoshop. The ultrasound gain was set at auto and depth at 4 cm, these remained constant throughout the study.

A single experienced operator scanned each needle shaft and tip at the various angles. For each needle, images were obtained in plane, with the transducer parallel to the needle. The needle and transducer were manipulated until the best images were obtained. These were then recorded to hard disc for later analysis.

Measurements

The ultrasound images were digitally recorded and transferred to a PC workstation and analysed using Photoshop programme. As per the method of Ingeborg Schafhalter-Zoppoth et al, regions of interest were defined using the magic wand tool (tolerance 10-35) and pixel intensity (PI) was measured. Pixel intensity was defined as the grey scale value between 0 (black) and 255 (white). The brightest regions of the shaft and tip of the needle were identified by a 'blinded' operator and the pixel intensity measured. The Pixel intensity value obtained was converted to a percentage of white (255) for ease of comparison, 100% for white (255) and 0% for black (0).

RESULTS

The results of our study are shown in table II.

The needles: At 10° angles of insonation all needles were visible. Ultrasound visibility increased with angulation with images brightest at 45° angle. The most echogenic needles were Polymedic followed by Pajunk.

Angle: In contrast to the previous studies by Schafhalter-Zoppoth et al (4), Kremer Nichols BS et al (5) and

TABLE II

ECHOGENICITY OF THE NEEDLES

	10°		30°		45°		60°	
	Shaft (PI)	Tip	Shaft	Tip	Shaft	Tip	Shaft	Tip
Polymedic	75% (192)	84% (213)	76% (195)	98% (250)	96% (250)	99% (254)	100% (255)	100% (255)
BBraun	56% (144)	41% (105)	81% (207)	62% (159)	84% (214)	86% (220)	57% (146)	78% (200)
Pajunk	66% (169)	66% (169)	98% (255)	78% (198)	99% (254)	99% (254)	99% (253)	100% (253)
Vygon	58% (148)	44% (112)	69% (176)	96% (245)	73% (186)	93% (236)	76% (193)	86% (220)

Maecken et al (6), all of whom reported reduced needle visibility with increased angulation, our study shows that needle visibility improved with increased angle insertion. The most suboptimal image was at 10° with a pixel intensity mean of 163.25 (63.9%) at the shaft and 149.75 (58.7%) at the tip. The brightest images were those at 45 o angle insertion with a mean pixel intensity of 226 (88.6%) at the shaft and 241 (94.5%) at the tip. The second brightest images were those at 60° insertion.

DISCUSIÓN

We present data which shows improving ultrasound echogenicity compared to previous studies. The study by

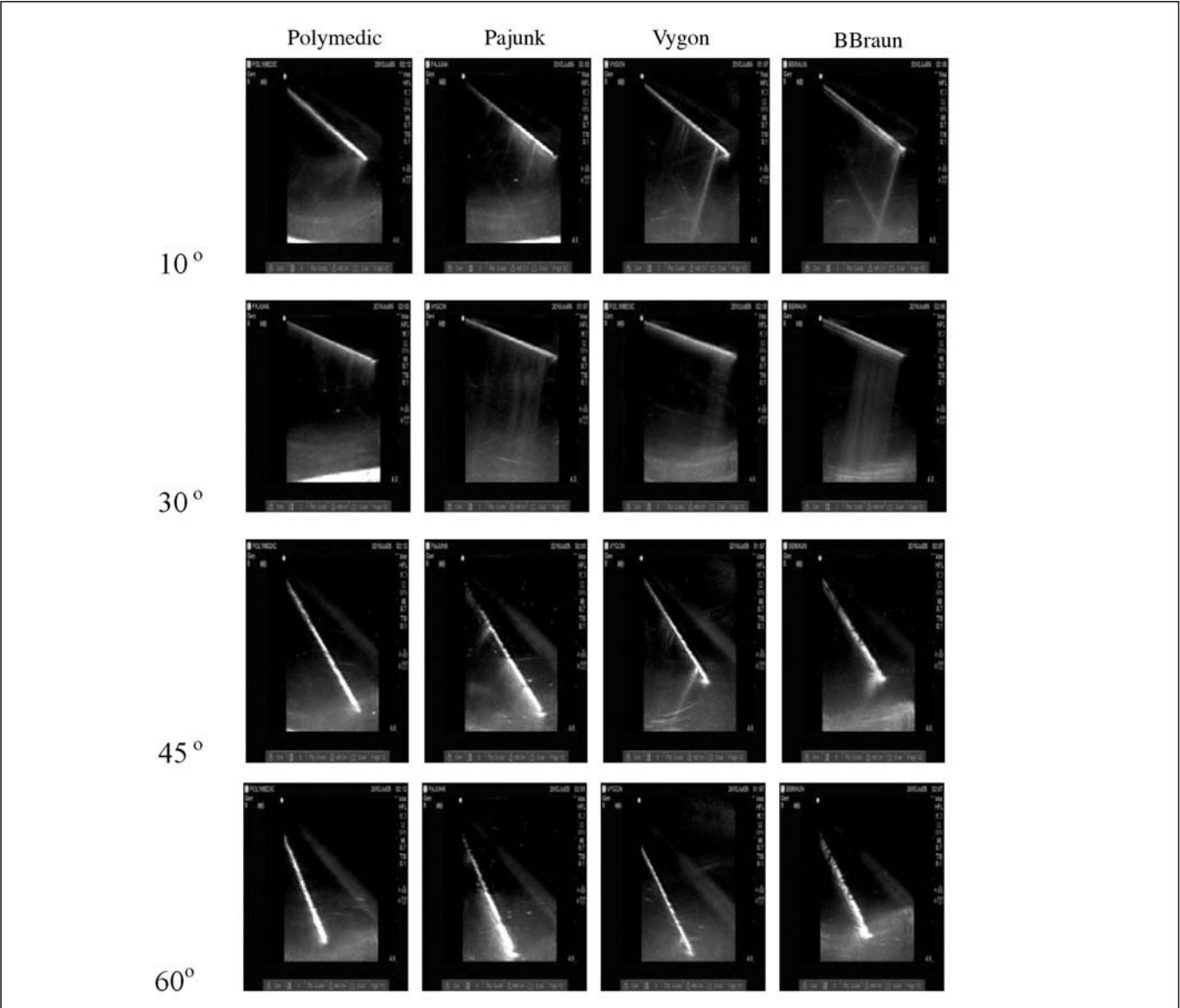


Fig. 1.

Schafhalter-Zoppoth et al. reported tip visibility at 60 degrees of PI 48 (18%) and a shaft visibility of 58 (22%) compared with 211 (82.7%) and 232 (90.9%) respectively.

Furthermore our study shows that with the current breed of echogenic needles, ultrasound image improves with steeper angle insertion due to their refractive properties.

Optimal needle visibility is crucial for successful and safe ultrasound guided peripheral nerve blocks. In clinical practice angles between 30 and 60 degrees are required. Our study shows that improvements in needle development have not only improved echogenic visibility but have also significantly improved visibility at steeper angles.

Needle visibility is a keystone of ultrasound-guided peripheral nerve blocks and as regional anaesthesia continues to grow in popularity, further developments in needle and ultrasound are required to ensure continued improvements in safety and efficacy.

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