

# ▶ Guidelines for filming digital camera video clips for the assessment of gait and movement disorders by teleneurology

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## Summary

Digital still cameras capable of filming short video clips are readily available, but the quality of these recordings for telemedicine has not been reported. We performed a blinded study using four commonly available digital cameras. A simulated patient with a hemiplegic gait pattern was filmed by the same videographer in an identical, brightly lit indoor setting. Six neurologists viewed the blinded video clips on their PC and comparisons were made between cameras, between video clips recorded with and without a tripod, and between video clips filmed on high- or low-quality settings. Use of a tripod had a smaller effect than expected, while images taken on a high-quality setting were strongly preferred to those taken on a low-quality setting. Although there was some variability in video quality between selected cameras, all were of sufficient quality to identify physical signs such as gait and tremor. Adequate-quality video clips of movement disorders can be produced with low-cost cameras and transmitted by email for teleneurology purposes.

## Introduction

Email is a powerful way of linking physicians in remote centres, such as those in developing countries, with specialists in tertiary care centres. The Swinfen Charitable Trust, established for this purpose in 1998, receives an average of 250 telemedicine referrals per year by email. About 10% of these referrals are neurological.<sup>1</sup> Over half of these neurological consultations are related to gait or movement disorders. Despite this, there are few reports in the literature about the use of telemedicine for movement disorders. Five studies have looked at the assessment of gait and complex movement disorders.<sup>2-6</sup> An additional study evaluated ratings on a standard Parkinson's disease rating scale by teleneurology.<sup>7</sup> To date, studies have used either Internet-based high- or low-bandwidth videoconferencing, or analogue

videotapes requiring digitization and compression. These methods, which were successful in pilot projects, have not been widely implemented since the necessary equipment is too expensive and complex to be used in many institutions.

Short videorecordings made by a digital camera ('video clips') and transmitted by email are a cost-effective and accessible alternative and require less expertise than more traditional videorecording and videoconferencing techniques. The requirements for achieving optimum and consistent quality of video clips are not known. The aim of the present study was to establish guidelines for digital camera videography of movement disorders.

## Methods

Four digital still cameras were used in the study: the Olympus C720, Nikon CoolPix SQ, Nikon Coolpix 2100 and the Canon IXUS 400 (Table 1). Using each camera, a simulated patient with a hemiplegic gait

Accepted 17 March 2005

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**Table 1** Digital camera characteristics

	Olympus C720	Nikon Coolpix SQ	Nikon Coolpix 2100	Canon IXUS 400
Frame rate (fps)	15	15	15	15
Resolution for high video quality (pixels)	320 × 240	320 × 240	320 × 240	320 × 240
Resolution for low video quality (pixels)	160 × 120	No low quality	No low quality	160 × 120
Maximum video duration (s)	70	40	15	180
Video format	MOV (QuickTime Motion JPEG)	MOV (QuickTime Motion JPEG)	MOV (QuickTime Motion JPEG)	AVI (Windows Media Player)
Audio	No	Yes	No	Yes

pattern was filmed by the same videographer in an identical, brightly lit indoor setting using a low image quality (LQ) setting (available on two of the cameras) with and without a tripod, and a high image quality (HQ) setting with and without a tripod. An action tremor was also simulated and filmed using LQ and HQ settings where available. The resolution for the LQ setting was 160 × 120 pixels, while HQ had a resolution of 320 × 240 pixels on all cameras. The Nikon Coolpix 2100's 'TV quality' setting, with a resolution of 640 × 480 pixels, was not used in our study, as the resulting video clips were too large to send easily by email.

After recording, video clips were transferred to a PC via a USB cable, and blinded. Audio was removed since this was not available on all of the cameras, and created larger file sizes. The video clips of hemiplegic gait were 6–9 s in duration and the video clips of tremor were 9–11 s in duration. Overall, the size of the clips ranged from 334 to 540 kByte using the LQ setting, and from 1.1 to 2 MByte using the HQ setting.

Six neurologists were asked to view the blinded video clips on their PC. Comparisons were made between cameras (Part A), between video clips recorded with and without a tripod (Part B), and between video clips filmed on HQ or LQ settings (Part C). In Part A of the study, neurologists were asked to rank the overall quality of the videos from each of the four cameras from 1 to 4. The neurologists were given three separate sets of videos to rank, with all sets containing only HQ videos. The first and second sets were videos of gait, with one set all filmed without a tripod, and the other with the tripod (to avoid confounding the results). The third set comprised videos of tremor. If the videos were judged to be of equal quality, they could be given an identical ranking (for example, if the two best videos were equal, the four videos would be ranked 1st, 1st, 3rd and 4th).

In Part B of the study, the six sets of gait videos filmed with or without the use of a tripod were compared directly against one another. Each comparative set was from a single camera, with two of the sets filmed on LQ, and four of the sets filmed on HQ settings.

Part C consisted of a comparison of LQ or HQ gait and tremor videos using the two cameras which had

both settings, the Olympus C720 and the Canon IXUS 400.

In Part D of the study, neurologists were asked if they could clearly identify the relevant physical signs (hemiplegic gait and tremor) on LQ and HQ videos from each camera.

## Results

In the rankings of overall quality (Part A), three of the cameras (the Olympus C720, the Nikon Coolpix 2100 and the Nikon Coolpix SR) ranked first place in at least one trial, as shown in Table 2. The mean ranks for the cameras were 2.3 (Olympus C720), 2.7 (Canon IXUS 400), 2.4 (Nikon Coolpix SQ) and 1.7 (Nikon Coolpix 2100).

In Part B of the study, videos filmed using a tripod were preferred in 14 cases, but made no difference in the majority of video clips (Table 3). Using Fisher's exact test, we calculated the *P* value for an association between type of camera and tripod preference as 0.0003, indicating that tripod preference may depend on the type of camera used. The largest departures from the expected values occurred for the Canon IXUS and Nikon Coolpix SQ.

In Part C, neurologists preferred the HQ video setting to the LQ video setting in 92% of the comparisons performed. However, in Part D, neurologists uniformly stated that they could still identify the physical signs (hemiplegic gait and tremor) in clips filmed with each of the cameras, including those filmed on a LQ setting. There was agreement that more subtle findings, such as myokymia or subtle facial movements, could have been more difficult to interpret on a LQ setting.

## Discussion

Use of digital camera video clips for the assessment of movement disorders is a simple technique that requires very little expertise. The equipment consists of a digital camera (with USB cable typically supplied), a PC and an email account with at least 2 MByte storage capacity.

**Table 2** Study Part A – ranking for three sets of four cameras’ high-quality video clips

	Olympus C720 rankings in each set	Nikon Coolpix 2100 rankings in each set	Canon IXUS 400 rankings in each set	Nikon Coolpix SQ rankings in each set
Neurologist 1	1st, 2nd, 3rd	2nd, 3rd, 1st	4th, 4th, 2nd	3rd, 1st, 3rd
Neurologist 2	1st, 1st, 4th	3rd, 1st, 1st	2nd, 4th, 2nd	3rd, 1st, 2nd
Neurologist 3	1st, 4th, 3rd	1st, 2nd, 1st	4th, 2nd, 2nd	3rd, 1st, 3rd
Neurologist 4	2nd, 1st, 4th	1st, 4th, 1st	2nd, 1st, 2nd	4th, 1st, 3rd
Neurologist 5	2nd, 2nd, 3rd	1st, 3rd, 1st	3rd, 4th, 2nd	4th, 1st, 3rd
Neurologist 6	2nd, 2nd, 4th	1st, 3rd, 1st	3rd, 4th, 2nd	4th, 1st, 3rd
Sum ranks for each set	9, 12, 21	9, 16, 6	18, 19, 12	21, 6, 17
Overall rank in each set	1st, 2nd, 4th	1st, 3rd, 1st	3rd, 4th, 2nd	4th, 1st, 3rd
Mean rank (SD)	2.3 (1.05)	1.7 (1.12)	2.7 (0.99)	2.4 (0.99)

**Table 3** Study Part B – number of neurologists who preferred video clips filmed with and without a tripod for each camera

	Video without tripod preferred	No difference between videos	Video with tripod preferred
Olympus C720		6	
Canon IXUS 400		1	5
Nikon Coolpix SQ			6
Nikon Coolpix 2100	1	4	1
Olympus C720 (LQ)	1	4	1
Canon IXUS 400 (LQ)		5	1
<i>Total scores</i>	2	20	14

Our goal was to establish how digital camera characteristics and settings affect the quality of movement disorder videos transmitted by email. We found that a HQ setting was strongly preferred, although a LQ setting was still acceptable for identifying the physical signs. Use of a tripod had less effect on video quality than we expected, although this may vary depending on the ability of the videographer to maintain a reasonably steady picture, and the type of camera used. There were some slight variations in the mean rankings of the four camera models we studied, although SDs were relatively large, and all cameras were deemed to be of sufficient quality for the physical findings to be identified.

These results have implications for physicians faced with the multitude of different models of digital cameras on the market, each with subtle differences in their specifications (Table 1). For example, many cameras do not have a choice of LQ or HQ settings. In certain circumstances, such as an intermittent myoclonic jerk or lengthy complex tic, a longer video clip may be preferable. Since filming on a LQ setting allows for a longer video clip while still maintaining the size under 2 MByte (the suggested maximum size for ease of email delivery<sup>6</sup>), it may be beneficial to have this option since neurologists still felt that they could identify physical findings on this setting. All of our

cameras had a resolution of either 320 × 240 (HQ) or 160 × 120 (LQ) pixels, and a standard frame rate of 15/s. Cameras are available with higher video quality, but the larger files that result may limit their applicability for email.

While our video clips were all under 11 s in duration, a limited video clip length, such as the 15 s provided by the Nikon Coolpix 2100, may be too short in some circumstances to capture a patient’s movements adequately. It may be preferable to select a camera which will allow filming as long as there is space on the recording card.

Digital camera video clips may be recorded in different formats, which in turn employ different compression/decompression algorithms. Our cameras used either a MOV format, which can be played with QuickTime, or an AVI format, which can be played with Windows Media Player. Other cameras may record videos in other formats, such as MPEG4. The two most common media players, Windows Media Player and Quicktime, can be freely downloaded via the Internet, but must be available to both sending and receiving parties, as specific recording formats require specific media players.

Two out of the four digital cameras did not have accompanying audio (Table 1). For movement disorders such as those seen in our videos, the addition of sound was not necessary, and indeed increased the size of the video clip incrementally. However, for patients with vocal tics or speech disturbance, it may be advantageous to have a camera with audiorecording capabilities. Digital cameras vary in price, depending on the specifications. From this study, we have found that even lower-priced cameras, such as the Nikon Coolpix 2100, costing approximately US\$250, can provide adequate video quality for email communications.

In the present study, we used a simulated patient to provide consistent physical signs on the multiple video clips we filmed. There is a possibility that videorecordings would have been more difficult to

interpret using an actual patient. We also assessed videorecordings of tremor and hemiplegic gait, but more subtle movement disorders may require a higher-quality setting to assess them. Finally, some of the video clips, as stated above, were viewed with Quicktime and some with Windows Media Player. Although the use of different media players to view the recordings may have introduced bias, it was felt that changing a videorecording into a different format might alter the quality with which it was intended to be viewed.

**Box 1** Guidelines for filming digital camera video clips of movement disorders

- 1 Choose a camera with:
  - an option for high- and low-resolution settings
  - a video recording rate of at least 15 frames/s
  - unlimited video clip length
  - audio (helpful in some circumstances)
  - a video format that plays in a media player which is available to both parties.
- 2 Use a tripod if available, although it may not be strictly necessary.
- 3 Film in bright indoor lighting or outdoors.
- 4 Avoid shadows and avoid filming near brightly lit windows.
- 5 Set the digital camera on its high-quality setting unless a longer video clip is strongly preferred.

In conclusion, we have established guidelines for creating digital camera video clips (Box 1). These will produce a satisfactory quality of video clip for the reliable demonstration of gait abnormalities and movement disorders. Whether or not this will significantly influence the diagnostic outcome in patients has yet to be determined.

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