# Electromagnetic Interference of Permanent Pacemakers by Mobile Phones in Thailand

CHARN SRIRATANASATHAVORN, M D.*,
SUKANYA POORANAWATANAKUL, B.Sc.*,
ULAN WONGKLAW, M.D.**,
SUPHACHAI CHAITHIRAPHAN, M.D.*

**Abstract**

The possible permanent pacemaker function interference by mobile telephones is concerned worldwide. Previous studies from the other countries with different mobile telephone systems and permanent pacemakers provided useful but indirect information. We *in vitro* studied the interaction between local mobile telephones and permanent pacemakers in Thailand. Seventeen mobile telephones from different systems and brands were tested in the laboratory with seven permanent pacemakers from different companies. We found no interference in the function of permanent pacemakers. The application of the information may be limited from the *in vitro* nature of the study. However this would be the useful reference for the future *in vivo* study.

**Key word :** Electromagnetic Interference, Permanent Pacemaker, Mobile Phone

**SRIRATANASATHAVORN C, WONGKLAW U, POORANAWATANAKUL S, CHAITHIRAPHAN S**
**J Med Assoc Thai 2000; 83 (Suppl. 2): S159-S162**

At the present time, there is widespread in the use of mobile phones in Thailand. The electromagnetic interference of permanent pacemakers due to mobile phones is frequently brought up by patients. The physician's advice is based on data mostly from Europe and North America[1-5]. This creates some uneasy feelings since precise information is dependent on different local factors. A study of the interaction between local mobile phones and permanent pacemakers would directly provide the answer to this concern. The purpose of this study was to investigate the effects of different

* Her Majesty Cardiac Center,
** Division of Cardiology, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

mobile phones on single and dual-chamber pacemakers that are commonly used in Thailand.

## MATERIAL AND METHOD

We systematically *in vitro* tested the interference of seven permanent pacemakers (both single and dual-chamber) from four companies with seventeen mobile phones. The cellular phones were in analogue (800 and 900 MHz), digital (1800 MHz and GSM) and PCT system.

After the selected sensitivity of the pacemaker was programmed (1mV for ventricular channel and 0.5 mV for atrial channel), the pulse generator was placed in a 0.9 per cent saline solution to simulate the body situation. The tip of the pacemaker lead was connected to the PRUCKA system to monitor the output from the pacemaker generator. The effect of a magnetic field on each pacemaker was verified before the mobile phones were tested. The sensitivity mode was tested in both bipolar and unipolar, if possible, for each pacemaker.

The phones were placed as close as possible to the pacemaker (around 20 mm) and carefully withdrawn (10 mm) each time to determine the maximum distance of interference. The test was performed in two modes: calling and receiving, with three phases in each mode: calling in or out, transmission and termination.

*Mobile Phone Characteristics:* The cellular telephones used in this study are listed in Table 1. For each telephone brand, we asked the companies to provide us the model with the strongest electromagnetic interference.

*Pacemaker Characteristics:* We used seven pacemakers from four manufactures for testing which are shown in Table 2. Currently these represent more than 80 per cent of the permanent pacemakers implanted in Thailand.

*Recording System*

The tip of the pacing lead was connected to the PRUCKA system which was routinely used in the electrophysiology study and radiofrequency catheter ablation. The amplifier of the PRUCKA system has high-pass filters of DC, 0.05Hz, 0.5Hz, 5.0Hz,30Hz,100Hz and low-pass filters of 500Hz. The gain of the amplifier was 50-10000 with gain linearity more than 96 per cent. The sampling rate of the recording part was 1000 samples per second. The monitor and recording system had the capability to measure the signal interval in a couple of milliseconds range.

**Table 1. Details of telephone system and its brand name.**

| Telephone System | Brand name |
|---|---|
| Analog 800 MHz: | Motorola Star TAC |
| Analog 900 MHz: | Nokia 434 |
| | Ericsson NH 238 |
| Digital 1800 MHz: | Nokia 7110 |
| Digital GSM: | Alcatel one touch view |
| | Bosch 608 |
| | Dancall HP2731 |
| | Ericsson GF788 |
| | Motorola Star Tac X |
| | Nokia 5110 |
| | Panasonic G500 |
| | Philips Genie NF |
| | Siemens S10 Active |
| PCT: | Uniden TP 11U |
| | Panasonic VE5058 |
| | Sharp SD-C4T |
| | NEC TN 401 |

**Table 2. Details of pacemaker manufactures and brand name.**

| Manufacture | Pacemaker Type |
|---|---|
| Medtronic: | Premia VVI |
| | Thera DDD |
| CPI: | Vigor SSI |
| | Vigor DDD |
| Teletronic: | Reflex VVI |
| | Reflex DDD |
| Pacesetter: | Regency VVI |

## RESULTS

For each pacemaker the effect of a magnet was verified. There was clear change in the pacing rate with the magnet as shown (Fig. 1 and 2).

However when the test was performed on seven permanent pacemakers and seventeen cellular phones, we found no interference in the pacemaker function at all. There was no change in the pacing rate, or programmed function with all modalities of the cellular phones.

## DISCUSSION

The result of the study is surprising since we did not find any interference with the pacemakers at all. This would give us some information

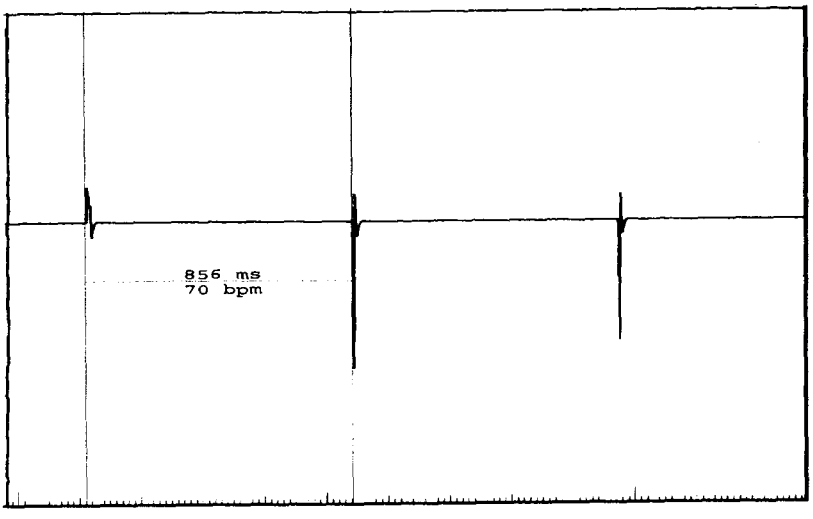


Fig. 1. In baseline, there was pacing output in the rate of 70/minute.

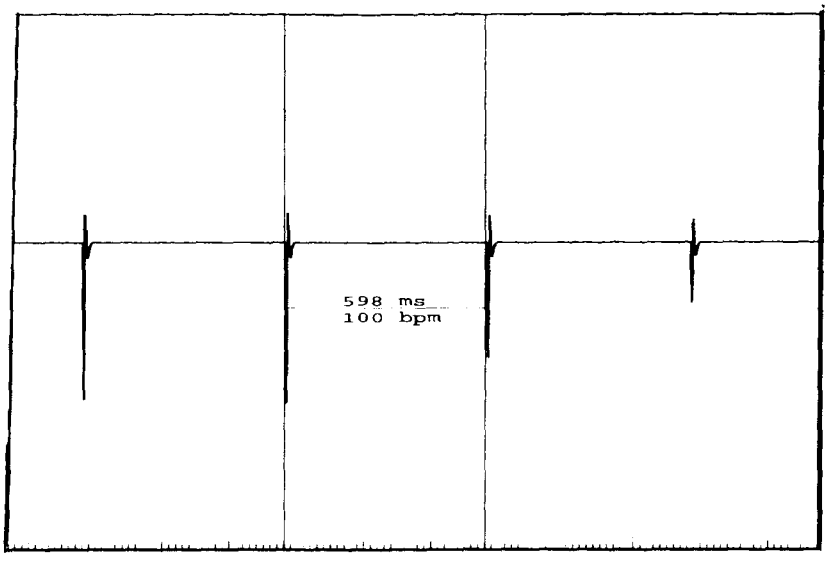


Fig. 2. With magnet, pacing rate increased to 100/minute.

to answer the question when the patient with permanent pacemaker wants to use cellular phones. However there are a lot of limitations to this study. The undersaline system that was used to simulate the inside body situation may not represent the real situation. The pacemaker models, cellular phone models and systems are rapidly changing. The models and systems used in the study would be out of date soon and the result of the study may not be relevant to the new devices. The most important issue is the *"in vitro"* study. Until the information from the systematic *"in vivo"* study is completed, one still has to be extremely careful to advise pacemaker patient since the chance of interference to pacemaker function by cellular phones cannot be completely excluded.

## SUMMARY

In the in vitro testing, there was no interference in commonly used permanent pacemakers from cellular phones in Thailand. However, there are limitations in the clinical utility of the study. The data would serve as basic information for systematic *in vivo* testing.

## ACKNOWLEDGEMENT

The authors would like to thank the Prime Medical Co.,Ltd., Guidant Intercontinental Corporation, Hope Thai Medical Co.,Ltd. and Louis T. Leonowens (Thailand) Limited for providing pacemakers for the study. Cooperation from major telephone companies Advanced Info Service, Total Access Communication and Telecom Asia Corporation are highly appreciated.

(Received for publication October 11, 2000)

## REFERENCES

1. Wai-Hong Chen, Chu-Pak Lau, Sum-Kin Leung, et al. Interference of cellular phones with implanted permanent pacemakers. Clin Cardiol 1996; 19:881-6.
2. Ruggera PS, Witters DM, Bassen HI. In vitro testing of pacemakers for digital cellular phone electromagnetic interference. Biomedical Instrumentation & Technology 1997;7:358-70.
3. Hayes DL, Carrillo RG, Findlay GK, et al. State of the science: pacemaker and defibrillator interference from wireless communication devices. PACE 1996;19:1419-30.
4. Wilke A, Grimm W, Funck R, et al. Influence of D-Net (European GSM-Standard) cellular phones on pacemaker function in 50 patients with permanent pacemakers. PACE 1996;19:1456-8.
5. Irnich W, Batz L, Muller R, et al. Electromagnatic interference of pacemakers by mobile phones. PACE 1996;19:1431-46.

# การรบกวนการทำงานของเครื่องกระตุ้นไฟฟ้าหัวใจชนิดถาวรจากโทรศัพท์เคลื่อนที่

*ชาญ ศรีรัตนสถาวร, พ.บ.*, อุษาร วงศ์แกล้ว, พ.บ.**, สุกัญญา ปูรณวัฒนกุล, วท.ม.*, ศุภชัย ไชยธีระพันธ์, พ.บ.**

ในปัจจุบันนี้มีการใช้โทรศัพท์มือถือกันอย่างกว้างของทั่วโลก การรบกวนการทำงานของเครื่องกระตุ้นไฟฟ้าหัวใจชนิดถาวรที่อาจจะเกิดขึ้นจากโทรศัพท์มือถือก่อให้เกิดความกังวลโดยเฉพาะในผู้ป่วยที่ได้รับการใส่เครื่องกระตุ้นไฟฟ้าหัวใจ ข้อมูลของการศึกษาในต่างประเทศมีข้อจำกัดในเรื่องความแตกต่างของระบบโทรศัพท์มือถือและเครื่องกระตุ้นไฟฟ้าหัวใจ คณะผู้ศึกษาปฏิกิริยาของโทรศัพท์มือถือ และ เครื่องกระตุ้นไฟฟ้าหัวใจที่ใช้ในประเทศไทยในห้องปฏิบัติการ โดยใช้โทรศัพท์มือถือทุกระบบที่มีในประเทศไทย จำนวน 12 เครื่อง และใช้เครื่องกระตุ้นไฟฟ้าหัวใจที่ใช้บ่อย 7 เครื่อง จาก 4 บริษัท ในประเทศไทย จากการศึกษา ไม่พบการรบกวนการทำงานของเครื่องไฟฟ้าหัวใจจากโทรศัพท์มือถือ 17 เครื่องดังกล่าว ข้อมูลจากการศึกษามีข้อจำกัดที่เป็นการศึกษาในห้องปฏิบัติการ แต่จะเน้นข้อมูลพื้นฐานที่ดี สำหรับการศึกษาในผู้ป่วยจริงต่อไป

**คำสำคัญ** : เครื่องกระตุ้นไฟฟ้าหัวใจ, โทรศัพท์เคลื่อนที่

**ชาญ ศรีรัตนสถาวร, อุษาร วงศ์แกล้ว, สุกัญญา ปูรณวัฒนกุล, ศุภชัย ไชยธีระพันธ์**
**จดหมายเหตุทางแพทย์ ฯ 2543; 83 (ฉบับพิเศษ 2): S159-S162**

* สำนักงานศูนย์โรคหัวใจสมเด็จพระบรมราชินีนาถ,
** สาขาหทัยวิทยา, ภาควิชาอายุรศาสตร์, คณะแพทยศาสตร์ศิริราชพยาบาล, มหาวิทยาลัยมหิดล, กรุงเทพ ฯ 10700