THE NORTHERN HOSPITAL

# MULTIFOCAL ATRIAL TACHYCARDIA

*"The Bellelli Family", oil on canvas, 1858-69, Edgar Degas, Musee D'Orsay.*

*"I have never seen angels. Show me an angel and I will paint one!".*

*Painting is an essentially concrete art and can only consist of real and existing things…an object which is abstract, not visible, non-existent, is not within the realm of painting!".*

*Gustave Courbet*

*For over two centuries Art had been mired in the staid and rigid conditions of what had become known as "Academic Art". The Renaissance had established the brilliant new methods of realistic painting, and in the mid-Eighteenth century the glittering age of Neoclassicism celebrated the rebirth of classical learning from that distant age. Over the centuries, however Art became increasing rigid, lofty decrees began to issue forth from the "establishment" that determined the "rules" of what constituted "great" Art, and similarly what did not. Increasingly conservative the great Academies (hence "Academic Art"), came to dominate and indeed dictate, taste, style, subject matter and anything else that mattered in Art and the greatest Academy of all was the Acadamie des Beaux-Arts in Paris. By the early Nineteenth century so powerful and influential had the academy in Paris become, that Artists' reputations, careers and even livelihood depended directly on its approval. All European Art was controlled by the Academy who determined whose and what works would be displayed to the public at the annual "Salon". Royalty and the public at large crushed into the Salons every year to see the very latest "approved" works.*

*Needless to say exclusion from the Salon was a devastating blow to the prospects of any aspiring and ambitious young Artist. The greatest good fortune that could befall a young Artist was to win the prestigious Prix de Rome. This was a competition that had been established in 1663 and that awarded the winner a scholarship of three to five years to study the Renaissance masters in Rome. Winners of this award were virtually guaranteed a successful and lifelong career. But by the 1830s it was becoming apparent there was now nowhere else for Art to go. And this was becoming a problem for a younger avant-garde generation whose creativity had been totally stifled. "You play by our rules or you starve", seemed to be the clear message from the monolithic Acadamie des Beaux-Arts. Angry young Artists increasingly protested. Their protests would have been a mere trifle to the Academy however, were it not for one unspeakable glitch, the public were becoming immune to the same old formulae, they didn't know quite what they wanted, how could that they didn't know anything else apart from what the Academy chose to present. All they knew was that they wanted something different. The anesthesia of familiarly had set in.*

*To break the hold of the Academies would take some extraordinary revolutionaries indeed. The story of the French Impressionists is now well known, but in fact it wasn't they who initially broke the power and influence of the great Academies. They were only able to accomplish what they did off the back of their predecessors in revolutionary change. The Artists that broke the centuries old status quo, where known as the Realists. They created the conditions that would allow Impressionism to evolve and to thrive and their longer tem legacy would be the freeing of Art from its centuries old shackles. The Realists saw that Art could be far more than fixed rules and intransigent traditions. Why could not Art have something to say about the modern world, and not just the ancient or classical world? And why only the grand and the mighty? Why not the everyday people going about their everyday lives, something that the great mass of ordinary people could viscerally identify with, something that had direct meaning to their own lives. The great champion of Realism Gustave Courbet, a sympathizer to the Paris Commune wrote, "I have never seen angels. Show me an angel and I will paint one!". He exclaimed, "Painting is an essentially concrete art and can only consist of real and existing things…an object which is abstract, not visible, non-existent, is not within the realm of*

*painting!". A revolutionary concept for the times, though of course Twentieth century, Abstract Expressionists, Post-Impressionists and Surrealists would ultimately put paid to that philosophy!*

*One of the earliest exponents of Realist painting was an Artist today known only as a great Impressionist. The only trouble is this Artist never accepted this label himself! History remembers Edgar Degas as one of the greatest Impressionists, and yet he always regarded himself as a Realist painter. To understand this apparent contradiction, one needs to understand, as with most history, the context of the times. Impressionism to Degas did not mean what it means to us today.- simply a visual style. But Impressionism in the Nineteenth century was more than simply a style of brushwork- it was a whole philosophy of Art - a philosophy which Degas did not entirely share. He trained in the classical manner and his early works clearly show his technical brilliance. Always embracing the modern he was greatly influenced by the style of the Impressionists, which he loved, yet he did not agree with many of their philosophies, and deliberately distanced himself from these. What he painted was the new Realism, everyday scenes of everyday people, almost exclusively women. Degas was a "Realist" in the manner of his* ***chosen subjects*** *- he just so happened to depict his Realist subjects in the modern impressionist* ***style****!*

*One Degas' most famous early works that even modern sensibilities would recognize as "Realist", is without a doubt his portrait of the "The Bellelli Family", 1858-69, a work that did not even come to light until after his death. Not the grand Monarch of Europe or some fabled figure from classical mythology, or some Emperor of Imperial Rome, but rather a very ordinary everyday family, his very own aunt with her husband and their two daughters. Degas loved his aunt Laura, and his two young cousins but his relationship with his aloof uncle was cold and difficult, he detested him in fact. Indeed aunt Laura detested her husband as well. Uncle Gennaro was much too busy to be bothered with his own family, let alone his nephew. "The Bellelli Family", is the archetypical dysfunctional family - the ordinary people were intrigued - many certainly felt an unsettling affinity. A very Realist work of Art indeed!*

*We see the family gathered together to have their portrait done, but this is not at all how the work was produced. Degas did not get them all together one afternoon to pose. Instead, as he did with most of his works, he produced numerous preliminary individual studies of each of the family members, capturing their personalities and particular traits. Degas usually reworked his canvases over and over, and with his Bellelli family portrait the work in fact took no less than nine years to complete! Immediately we sense the tension, and it does not seem a great mystery why Degas could not assemble the whole family for days at time in order to paint them! The pyramidal arrangement of Aunt Laura with her two daughters, Giovanna on the left and Giulia on the right, immediately separates them from Uncle Gennaro, who has his back to the viewer. There is clearly a profound distance between husband and wife. The marriage was probably an arranged one. Gennaro barely disdains to join in the proceedings, clearly agitated that he has been disturbed from his business, his papers momentarily closed on the table. Indeed some surviving sketches show that Degas originally intended to depict Gennaro in a front on posture at the end of the table, but later he changed his mind to have Gennaro with his back to the viewer. The unmet and unanswered gazes of husband and wife emphasize*

*their isolation from each other. We see for the first time Degas' fascination with the theme of isolation of the individual even within a family unit, a motif he would carry with him in his future works, as if to reflect his own isolation.*

*Aunt Laura stares expressionlessly off into the distance neither engaging the Artist or her husband, though she does cast a motherly hand over the shoulder of Giovanna, the only one of the group who at least tries to engage the Artist. Giovanna is clearly the obedient and good child, perhaps her mother's favourite. Giulia however, is the very picture of agitated defiance, the rebel of the family, perhaps her father's daughter! She seems distracted by something that has caught her eye out of the window. She has one hand impatiently on her hip. One leg is bent up under her while the other is thrust forward as if in readiness to suddenly leap away from the whole scene! Gennaro himself was a political exile from his native Naples because of his subversive ideas on Italian unification, and in consequence had to flee Naples for Florence. Laura was very unhappy in exile, indeed her unhappiness at the time of the portrait was greatly compounded by the recent death of her father, and Degas's grandfather, Hilaire De Gas, whose portrait we see hanging in the background.*

*The atrial myocardium is like a harmonious family unit. Each myocyte member in perfect synchrony with the others, all directed and lovingly coordinated from parental SA and AV nodes. In the condition MFAT however we are reminded of Edgar Degas' Realist family portrait of his Bellelli relatives! Though the family unit remains together, sadly they are not in compete harmony with each other.*

*Study of Giulia Bellilli, oil on paper, mounted on canvas, 1858-59, Edgar Degas. Dumbarton Oaks Research Library and Collection, Washington D.C*

# MULTIFOCAL ATRIAL TACHYCARDIA

## Introduction

**Multifocal atrial tachycardia (MFAT)** is an irregular supraventricular rhythm caused by **3 or more** different sites of atrial ectopy, a rate of > 100 beats per minute.

Patients with multiple P wave morphologies but a *normal heart rate* (i.e. 60 to 100 beats per minute) are considered to have a **wandering atrial pacemaker**, (or multifocal atrial rhythm) since the heart rate does not meet criteria for a tachycardia, (i.e. > 100).

The rhythm of itself is usually benign, not requiring specific therapy.

It is not amenable to cardioversion.

Treatment instead consists of attention to the underlying cause.

### *Terminology:*

**Automaticity** refers to normal, accelerated normal, or abnormal pacemaker activity.

**Triggered activity**, on the other hand, results from a normal stimulus giving rise to after-potentials, which, if threshold is attained, can result in regenerative action potentials in any cardiac tissue.

**Re-entry** refers to a circuit in which previously excited tissue is re-excited, producing an extra beat or a sustained rhythm.

The occasional responsiveness of MFAT to verapamil suggests intracellular calcium overload causing after-depolarizations leading to triggered activity as the underlying mechanism

## History

Although this abnormality had been noted for many years during some types of atrial tachycardia, the term MFAT (or MAT) did not become commonplace terminology until the late 1960s.

## Prevalence

MFAT is an uncommon but not a rare arrhythmia.

The average age is approximately 70 years and these elderly patients are generally quite ill with pulmonary, cardiac, or other serious diseases.

## Pathophysiology

The aetiology of MFAT is uncertain.

It is thought that MFAT results from right atrial hypertension and distension, either from secondary pulmonary hypertension from advanced COPD or left ventricular dysfunction caused by comorbid processes such as coronary heart disease, systemic hypertension, or aortic stenosis.

However, although frequently associated with exacerbations of pulmonary disease, MFAT may also occur in other circumstances, so atrial distension may not be the universal mechanism.

The variable P wave morphologies are thought to reflect differencing sites of atrial origin. *Alternatively*, a single focus with different exit pathways or abnormalities in intra-atrial conduction could also produce identical electrocardiographic findings.

MFAT may be associated with or precede atrial fibrillation

*Causes:*

1. COPD:

    - This is the commonest cause and is seen with hypoxia in elderly patients with exacerbations of chronic lung disease, such as caused by pneumonia.

      **Hypoxia, hypercapnia** and **acidosis** all contribute as probable triggers.

    - It is possibly also related in some cases to beta agonist effects in patients being treated for COPD.

*Other causes are somewhat less certain and less common, but there have been associations with:*

2. Cardiac disease:

    - IHD/ CCF/Hypertension

3. Pulmonary embolism, (uncertain)

4. Electrolyte disturbances:

    - Hypokalaemia

    - Hypomagnesaemia

5. Drugs:

    - Sympathomimetics agents, in particular:

- ♥ Aminophylline
- ♥ Theophylline
- ♥ Isoprenaline

- Digoxin toxicity, (less certain correlation).

6. Sepsis in general.

## Clinical Features

Of itself MFAT is usually fairly benign and does not normally provoke hemodynamic compromise.

MFAT is usually a transient arrhythmia, which may spontaneously revert to sinus rhythm, or it may progress to AF or atrial flutter.

Symptoms are usually related to the underlying illness, rather than the MFAT itself.

Occasionally symptoms may be related purely to the fast heart rate, (i.e. distressing palpitations).

A wandering atrial pacemaker (rate < 100) usually occurs in the asymptomatic patient or at least in less ill individuals.

## Investigations

These will be directed according to the index of suspicion for a particular cause.

*Blood tests:*

These may include:

1. FBE
2. CRP
3. U&Es/ glucose, (urgent potassium level)
4. Magnesium/ calcium levels
5. Troponin, (if an ACS is suspected).
6. Serum drug levels:

- Digoxin level

- Theophylline level

7. TFTs

*ECG:*

1. **3 or more** morphologically different P waves (best seen II III AVF V1) - in the same lead.

2. Rate > 100 per minute:

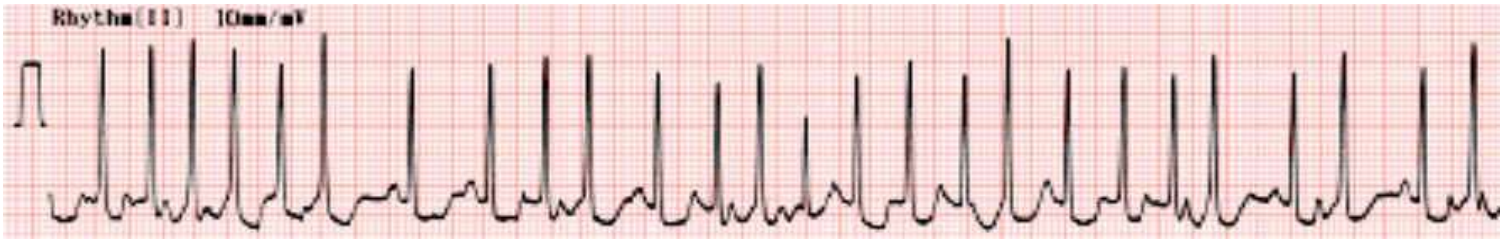
   - A somewhat arbitrary cut-off point it should be noted, in order to distinguish MFAT from the "wandering atrial pacemaker", of heart rates < 100 beats per minute.

     Some literature suggests a cut-off point of > 90.

3. Normal QRS

4. Irregular (variable P-P, P-R, R-R intervals)

5. An **isoelectric baseline** between P waves, to differentiate MFAT from AF (which it may easily be confused with) and atrial flutter.



*Lead II rhythm strip showing multifocal atrial tachycardia. Note the differing morphologies of the P waves.*

*Differential ECG Diagnosis:*

The differential diagnoses which may be difficult to distinguish from MFAT is similar to that of other narrow QRS complex tachycardias with an irregular rhythm (assuming there is normal AV conduction without bundle branch block) and these include:

1. Sinus tachycardia with frequent atrial premature beats

2. Atrial flutter with variable AV conduction

3. Atrial fibrillation

MAT can usually be differentiated from both atrial flutter with variable AV conduction and sinus tachycardia atrial premature beats by the regular P-P interval seen in both atrial flutter and sinus tachycardia, which is not present in MAT.

MFAT, with its organized atrial activity resulting in P waves on surface ECG, can be readily distinguished from atrial fibrillation, which lacks any discernible P waves.

However, MFAT can and does degenerate into atrial fibrillation in some patients.

## Management

Specific treatment of this arrhythmia is rarely needed and is often not helpful.

1. **Treat the underlying cause:**

   Treatment should be aimed at the underlying disease process, most commonly exacerbation of COPD or attention to excessive beta agonist therapy if this is thought to be a contributory factor.

   - Correct any hypokalaemia or hypomagnesaemia
   - Treat any hypoxia/ hypercarbia
   - Treat any sepsis

2. Rate control:

   Rate control is only indicated if MFAT causes a sustained rapid ventricular response that is thought to be contributing to myocardial ischemia, heart failure, poor peripheral perfusion, or oxygenation.

   It may also be considered for distressing symptoms

   Rate control (if required) may be attempted with:

   - IV $MgSO_4$:
     - ♥ The administration of magnesium can suppress MFAT in hypomagnesemic patients and, at times, in apparently normomagnesemic patients.
   - Oral or IV metoprolol:
     - ♥ Use of beta-blockers in MFAT is usually limited because of the risk in patients with underlying heart failure or chronic obstructive pulmonary disease, particularly with bronchospasm.

**Esmolol infusion**, because of its short half life, may be the best option as beta blockers are relatively contraindicated in COPD and significant heart failure, especially right-sided heart failure.

- Oral or IV verapamil:
    - ♥ This is an alternative agent for patients in whom beta blockers are contraindicated

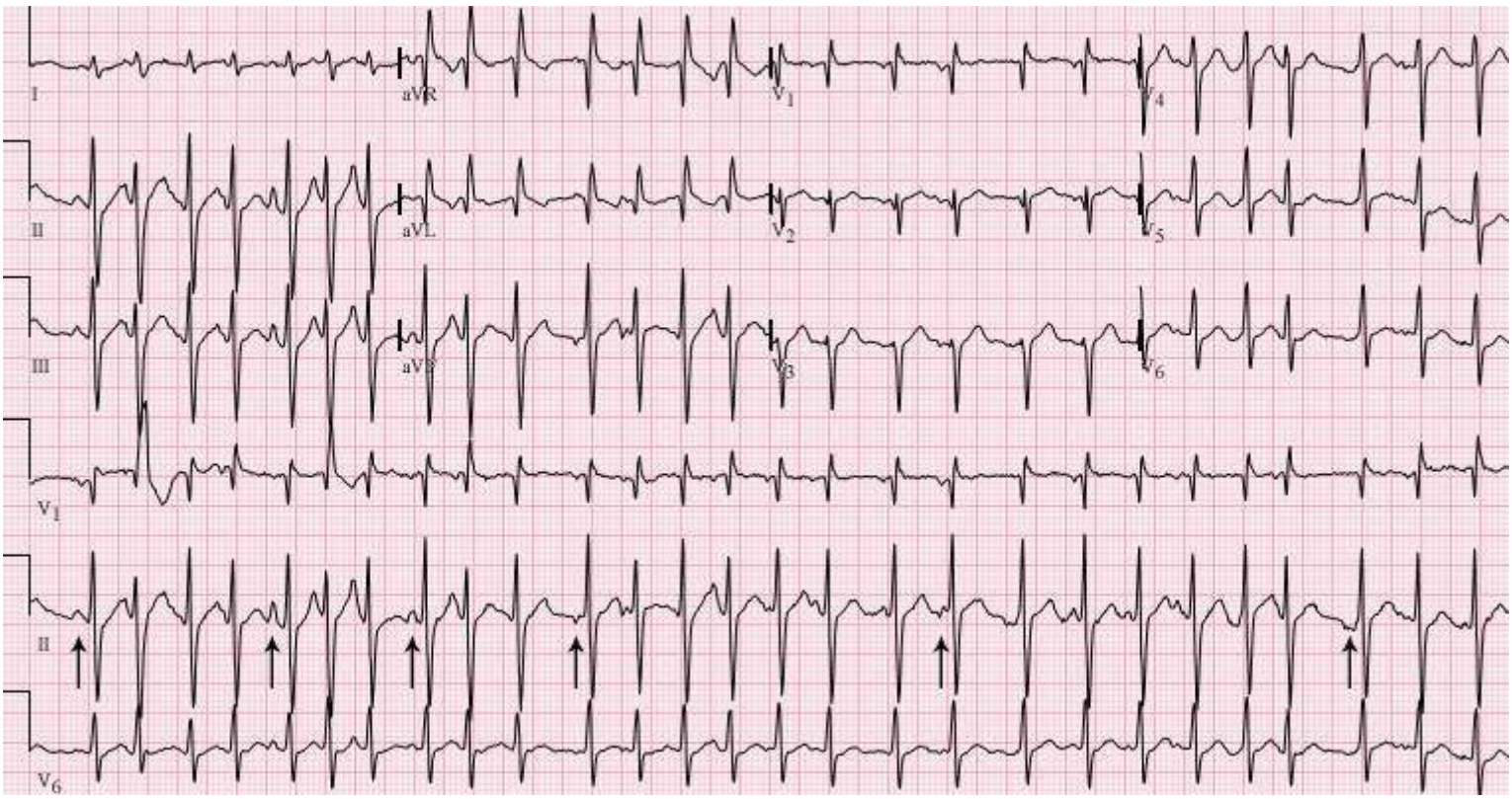
*Other anti-arrhythmic agents:*

- These appear **not** to be effective.
- Digoxin may cause increased mortality in patients with MFAT

3. Cardioversion is **not** effective, (and attempts may be detrimental).

4. Radiofrequency ablation:
    - Ablation of the AV node and the use of a permanent ventricular pacemaker is a further option for patients with *sustained and symptomatic* MFAT who do not respond to, or cannot tolerate, pharmacologic therapy.

## Appendix 1




*12 lead ECG of a patient with multifocal atrial tachycardia. Arrows demonstrate the variable P wave morphologies.*

*References:*

1. Alfred Buxton, MFAT in Up to Date Website, 30 September 2015.

Dr J. Hayes
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